UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

ANIMAL HUSBANDRY RESEARCH DIVISION

and

COOPERATING WESTERN STATES

W-1 - IMPROVEMENT OF BEEF CATTLE THROUGH THE APPLICATION OF BREEDING METHODS

1966 Annual Report of W-1

and

Report of

Annual Meeting of Technical Committee

University Park, New Mexico

July 7, 8, and 9, 1966

This report is intended for the use of administrative leaders and workers and is NOT for general distribution

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AGENDA

W-1 Technical Committee Meeting

New Mexico State University
University Park, New Mexico
July 7, 8, and 9, 1966

H. H. Stonaker, Chairman

Thursday

8:30 A.M. Welcome
Dr. Marvin L. Wilson, Associate Director
New Mexico Agricultural Experiment Station

9:00 A.M. Station Reports
Arizona, Colorado (lipid project), Hawaii, Idaho, Nevada, New Mexico, Oregon, Washington, Wyoming

1:30 P.M. Recent Research Developments in S-10
Dr. Marvin Koger, Professor
Animal Science Department, University of Florida

2:00 P.M. Discussion of First Proposed Regional Bulletin

1. Proposed title and outline
   J. S. Brinks

2. Procedures for assembling review material
   C. B. Roubicek

3. Procedures for assembling materials and methods section
   Ralph Bogart

4. Possible procedures and statistical models for studying:
   a. Effects of inbreeding of sire, dam, and mating on fertility
      R. E. Christian and B. W. Knapp

   b. Effect of inbreeding of calf and dam on calf survival
      H. H. Stonaker and G. E. Nelms

   c. Effect of inbreeding of calf and dam on weights, gains, scores, and feed efficiency
      J. A. Bennett and E. H. Cobb

   d. Interactions of levels of environment with levels of inbreeding
      C. M. Bailey and R. L. Blackwell

5. Possible procedures for studying trends in variability within and between inbred lines
   W. C. Rollins and L. A. Holland

6. Methods of publication
   O. F. Pahnish and H. H. Stonaker

7. Authorships
   C. C. O'Mary and W. C. Rollins

Friday

8:30 A.M. Preliminary Summaries of Regional Data to Date
B. W. Knapp

10:00 A.M. Project Revisions and Supplements
Arizona
California
U. S. Range Livestock Experiment Station

1:00 P.M. Business Meeing

Reports
J. H. Meyer, Administrative Adviser, W-1
M. J. Burris, Representative, Cooperative State Research Service
E. J. Warwick, Chief, Beef Cattle Research Branch
J. S. Brinks, Investigations Leader

Saturday

8:00 A.M. Tour Jornada Experimental Range and College Ranch

PERSONNEL

Project Leaders

Carl B. Roubicek*	Arizona
W. C. Rollins*	California
H. H. Stonaker*	Colorado
Estel Cobb*	Hawaii
Ross E. Christian*	Idaho
R. L. Blackwell*	Montana
C. M. Bailey*	Nevada
Lewis A. Holland*	New Mexico
Ralph Bogart*	Oregon
James A. Bennett*	Utah
Joe K. Hillers**	Washington
George E. Nelms*	Wyoming
O. F. Pahnish	U. S. Range Livestock Experiment Station

Administrative Adviser

J. H. Meyer	California

Agricultural Research Service

J. S. Brinks	Investigations Leader
Bradford W. Knapp	Statistician
E. J. Warwick	Chief, Beef Cattle Research Branch

Cooperative State Research Service

Martin J. Burris	Principal Animal Geneticist

Guests Present

Marvin Koger	University of Florida
John Knox	New Mexico State University
Donald E. Ray	University of Arizona
Dave A. Cramer	Colorado State University
Marvin L. Wilson	New Mexico State University
A. L. Neumann	
A. B. Nelson	
Bobby J. Rankin	
Earl E. Ray	
Jim Gosey	
Gary V. Richardson	Agricultural Research Service Biometrical Services

*Voting members
**Representing C. C. O'Mary

W-1 Technical Committee Meeting
New Mexico State University
University Park, New Mexico
July 7, 8, and 9, 1966

H. H. Stonaker, Chairman

The W-1 Technical Committee convened at 8:30 A.M. in the Conference Room of the Agriculture Building. The meeting was called to order by Dr. Stonaker, who introduced Dr. Marvin Wilson, Associate Director, New Mexico Agricultural Experiment Station.

Dr. Wilson:

We are most happy to have you on campus. Most of you will stay over next week and will have an opportunity to see the program under way.

This gives us a chance to make new friends and renew acquaintances. It is amazing how many of the old timers there are here. Ralph Bogart was on my Graduate Committee. We are glad to welcome back to our campus Marvin Koger, Bob Blackwell, and Estel Cobb.

The State of New Mexico is one of contrast. It is the fifth state in land area. Ninety percent of the acreage is used for agricultural production of one type or another. Thirty-five percent is Federally owned. Ninety percent of the cash receipts are from 10 percent of our area. Agriculture uses about 90 percent of the total water in the state for agricultural production. The University of Arizona is closer to us than many of our branch stations.

Our program does not differ much from most of the agricultural research stations. We have five branch stations and a new one being developed. The overall program has changed considerably over the years. Earlier it was mostly what we called applied research. Today there is a considerable amount of fundamental or basic research being carried out at the experiment station.

In looking at our Animal Science Department, we have a new department here. Al Neumann, Head and Professor of Nutrition, and nine or ten other men have been with us not more than three years' time. The Animal Science Department is in a period of expansion and development. Projects are being revised and new projects being introduced.

We are most happy to have you here. I congratulate Lewis Holland on getting the plush conference room.

Dr. Stonaker:

I want to draw to your attention the fact that it has been 20 years since W-1 was formed. In Salt Lake City, Utah in the summer of 1946, this Committee was formed. It may be a bit unusual in a country so dedicated

to the cult of change, but we do take pleasure in counting off decades, centuries, and so on, so we should consider our two-decade age at this meeting.

Another thing is that I take pride in the fact that I am the only one still on the committee who was on that original committee two decades ago. How I have done it is that the other people at that meeting got their advancements and promotions a lot earlier than I did!

Retrospectively, we were in on the ground floor of a very important movement. In these 20 years we have interjected science and concepts of science in this matter of beef cattle breeding. It was treated as any other aspect of agriculture. It had been successful, and the bulwark of economy in the West, and when things are successful it is difficult to make innovations. But there has been a great deal of interest develop because of this scientific research. The big changes in the 20 years (but in small numbers) have been in mental attitudes. We can be proud that we have participated in this early stage in the cattle industry in the best traditions of this country. I have no personal doubt that some day there will be a centennial celebration of W-1, for it must be a continual and continuous effort.

We have just begun to realize that in cattle we have a splendid laboratory animal with which to work. In cattle we have the numbers to work with. From the vast quantities of blood, bone, and tissue that can be measured in the hundreds of pounds, the biologist might find the quantities of materials from which he can isolate material to be measured in micrograms. It should keep some young Ph. D.'s working for some time.

We have an experimental leverage in twins that we must not overlook, and we must not let others overlook it.

In the next decade we are going to need heavy hitters to work at this. I think the heavy hitter in this case should be our population geneticist, because we need that man on a team to point the way.

Some things we need to take a heavy hit at include:

<u>Hybrid Vigor</u>: We have not exploited it, but we are going to have to exploit it. Also, we need to evaluate gains as a result of breeder involvement of more breeds. Ultimately the final checking of this flood is going to depend to some extent on inbred lines.

<u>Genetic-Environmental Interactions</u>: The work at Nevada is ahead of the rest of the country. It is likely to become a beef cattle classic. It is in good hands, and let's keep it that way. One run is in because of the action of this committee. The original design was the result of a compromise. This committee went on record as saying to Nevada, "Start out right," and it has been carried through, much to the credit of Nevada. We are in the swing, so let's not drop the bat.

The cooperative work of Arizona and Hawaii is getting along reasonably well, but can't we put a little more muscle in the swing?

Jim Bennett told me about some of the work on the cleft palate problem at Utah. It is a sophisticated problem of particular importance. All I can say is I hope we will have the muscle to swing through.

The double muscling problem in California sounds intriguing. Let's see what can be worked out on that.

Growth and Efficiency: We are still swinging around in this without getting the efficiency to come out quite the same as the gains do. Why can't we solve this thing? We are not swinging with quite enough muscle.

We have business to attend to at this meeting. We have ideas about funds and publications that need to be discussed.

At this 20th anniversary we have many reasons to be happy and pleased with what has been undertaken and we would like to welcome the new ones aboard.

Professor Knox is with us, and I don't think anyone has set the pattern for beef cattle research history and has been more devoted to the purposes and intent of W-1. I would like to have Professor Knox give us the benefit of his comments.

Professor Knox:

I apologize for taking any of your time, but Stony insisted. I won't do much more than say "Hello" and say we are glad you are here. Actually, I have had not too much connection with W-1, but it has always been represented in New Mexico and I know all the problems and preparation by one man, and we should not forget him. I remember well when Dick Clark came here. I thought he was pretty far out in left field. I thought he would never get us into cooperative research on this scale. But he did and I think we should bear that in mind and give him credit. There were many problems he bore in connection with this research project.

I can see now that things have changed a lot. Personnel have changed and the projects have changed. Of course, everything has to change. I think probably you men now are facing problems more complex and bigger than the original group faced when they got started. You are going to have to make big changes yet, and decisions are not going to be easy to make. But I have confidence you are going to make the right ones and we are glad you are here working with us.

Dr. Stonaker:

Our guest speaker this year is Dr. Marvin Koger, who needs no introduction to this group as New Mexico is his old stamping ground and I am sure this is where many of his interests lie. Marvin gave a great deal of his strength to this project in its initial days and I am sure it was with a great deal of concern about the project that he left, but his career has continued in Florida. We have an unusual opportunity in having Marvin give us his views, knowing the West as he does, then going to an entirely different area with different climatic problems. I am sure we are very glad to have Marvin come to us with his understanding of S-10 and his interest in W-1.

GENETIC-ENVIRONMENTAL INTERACTIONS IN BEEF CATTLE

Marvin Koger
Department of Animal Science, University of Florida
Gainesville, Florida

That genetic-environmental interactions occur in a broad sense is beyond reasonable doubt. In the plant kingdom, for example, the Loblolly pine of Florida will not grow in the Rockies, nor will Ponderosa of the Rockies survive in the flatwoods soils of Florida. The restricted range of adaptability of varieties of various species of farm crops is well known to everyone in agriculture. Although not so obvious or numerous, there are overwhelming evidences of genotype-environmental interactions in the animal kingdom, also. For example, certain groups of fishes can live in either salt or fresh water while others can live in fresh water only. Within the species of main interest to this group, the Zebu is adapted primarily to the more tropical climates while the Scotch Highland is better suited to cold climates and completely unadapted to the tropics.

The responsibility of cattle breeding specialists, thus, is not that of proving the absence or presence of genotype-environmental interactions. We know already that they exist. The problem is to determine the ranges in genotype and environment over which they are large enough to be of economic importance. After fifteen years' experience in the unusual environment of Florida, it is the opinion of the author that genotype-environment interactions are of much greater importance in the improvement of ruminants than is generally believed. The objective of this presentation is to discuss the nature of genotype-environmental interactions in light of experience in Florida and to speculate on some implications in the improvement of beef cattle, especially for unfavorable environments.

The Nature of Genetic-Environmental Interactions

Assuming that genotype-environmental interactions are of significance, there are two classes of possible interactions of interest in animal breeding:

(1) Interactions involving environmental and nonadaptive genetic differences

Genetic differences in traits such as potential growth rate or mature size are relatively unrelated to adaptation. Variation in genetic potential for such traits in combination with different environments, however, can conceivably lead to significant interactions in response. Good growth potential is retarded under restrictive environments but not in good environment, while a limited growth potential may be much less influenced by environment. A similar situation may be visualized for a variety of traits.

(2) Genotype-environmental interactions involving differences in genetic adaptations

Genotype-environment interactions that arise as a consequence of

adaptive genetic changes taking place in different environments are of much greater interest in beef cattle breeding. If adaptive genetic changes do occur, it follows that animals moved into a foreign environment, particularly an unfavorable one, would not perform on the average as well as animals which had become better adapted to the environment. Following are some of the environmental factors which, combined with natural selection, may lead to adaptive genetic changes:

Terrain. The physical characteristics of terrain such as topography, distances required to obtain adequate water or feed supply, and lack of shade may impose demands on animals that exert natural selection for adaptive characteristics.

Temperature and humidity. In a broad sense genetic tolerance for high or low temperatures has undoubtedly entered into the evolution of groups as divergent as the Zebu and some of the European breeds. Heat and humidity exert some stress on cattle in southeastern United States during certain seasons. In all likelihood, stocks maintained over long periods of time in this area will evolve hair coats shorter than that generally found in the British beef breeds. In the opinion of the writer, however, the importance of heat tolerance in cattle has been grossly overestimated. Heat tolerance scores have shown no relationship with performance in beef cattle at Jeanerette, Louisiana (Vernon, et al., 1959). The apparent negative relationship between heat tolerance and production in dairy cattle is well known. British breeds of beef cattle compete favorably with Brahman cattle as far south as the Everglades in Florida. Production performance of the Angus herd at the North Florida Station at Quincy exceeds that of any other institutional Angus herd in the United States for which data have come to our attention. The production of the better dairy herds in Florida is very good. Obviously, heat tolerance is not the major problem afflicting cattle performance in Florida. It appears likely that its importance for the subtropics and tropics has been overestimated, also.

Solar radiation. This is an important factor influencing the heat load of animals. A hair coat and pigmentation that screens out harmful rays is an important characteristic contributing to heat tolerance, especially in the absence of shade. Where radiation is a problem, natural selection would tend to develop protective pigmentation and hair coat. This evidently has occurred in the Spanish cattle introduced into the American tropics.

Quality of forage. Poor quality fibrous forage is digested better by Brahman cattle than by British cattle (Howes et al.,1963). One of the characteristic problems of cattle introduced onto Florida pasture appears to be an inability to utilize roughage. The importance of genotype in this capacity is not known. It does not appear unreasonable, however, to assume that genetic differences do exist and may respond to selection.

Parasites. Genetic differences in tolerance for internal parasites in sheep are known to exist (table 1). The importance of such differences in cattle are not known but may be of importance. Genetic tolerance

TABLE 1. PRODUCTION PERFORMANCE IN SHEEP FROM DIFFERENT BREED GROUPS AT FLORIDA FROM 1963 THROUGH 1965

	Rambouillet Group[a]			Florida
	Alabama	Florida	Texas	Native
Heat periods per conception	1.3	1.2	1.2	1.0
Percent ewes lambing	91	98	80	96
Average lambing date	12-11	12-19	12-17	12-17
Percent lambs dropped	113	113	95	125
Percent survival--birth to May 20	77	88	72	96
Percent lambs, May 20	87	99	68	120
May 20 lamb weight, lbs.[b]	66	74	65	69
Lbs. lamb per ewe, May 20[b]	57	73	44	83

[a]Alabama group transferred from Auburn April 1962. Florida flock established from Texas foundation in 1955. Texas group introduced April 1962.
[b]Includes data from 1963 and 1964 only. May 20 data from 1965 not yet available.

for the Texas fever tick by Brahman cattle is well known. It is the general belief among Florida cattlemen that the Florida Native had better tolerance for the tick than cattle of improved breeds.

Disease organisms. Tolerance for disease organisms that are prevalent may well be the most important factor contributing to adaptability. Physiological factors such as antigen-antibody reactions are known to be important. Genetic implications may be of much greater importance than generally assumed. This is an area that needs investigation. It is the opinion of the writer that lack of genetic tolerance for certain disease organisms prevalent in the area, along with inability to utilize poor quality roughage efficiently, is the major deficiency of most European cattle introduced into Florida.

Correlated responses may result in genetic attributes which lead to genotype-environment interactions, sometimes possibly with surprising results. For example, it is generally assumed that natural selection is for a high rate of reproduction, since individuals with this attribute produce large numbers of offspring. Where quality of feed is a severe problem as in Florida and the tropics, however, such is not the case. Under natural range conditions in Florida, the calf that was most likely to survive was one that had a good-milking dam, and the cow that was most likely to survive and leave a number of offspring was one that failed to breed back while she was nursing a calf. Is it any wonder, then, that the typical Florida Native or unimproved Zebu type animal is a good milker that reproduces on alternate years in almost perfect rhythm? Under unfavorable environmental conditions, superiority in one trait with survival value may be associated with poor performance in another trait. We have evidence in Florida (Kirst, 1964) showing that good milking ability was associated with failure

to breed while nursing on semi-improved pastures.

That one of our major breeds, noted for regular reproduction under sparse range conditions, is concurrently cursed with poor milk production is not surprising. Nor should it be surprising to encounter genetic-environmental interaction when cattle with these genetic attributes are compared with other cattle under various environmental conditions.

Genetic-Environmental Interaction Studies in Florida

Florida has two cattle breeding projects which deal specifically with genotype-environment interactions.

(1) Influence of breed composition and level of nutrition on adaptability of cattle to Florida conditions (project 615)

This project is in its 14th year. Five groups of cows with different proportions of Brahman (B) and Shorthorn (S) breeding are maintained on each of three pasture programs. The pastures include low quality native pasture, a combination of native and improved pasture, and irrigated improved pasture with supplemental feed to maintain a high level of nutrition. The breed groups include B, 3/4B 1/4S, 1/2B 1/2S, 1/4B 3/4S, and S. Mean values for weaning weight show that the Shorthorn has responded more to increased levels of nutrition than the Brahman. The mean values for reproduction likewise suggest a breed × pasture interaction, but with the breeds ranking differently than for growth. A preliminary analysis of the data by Reynolds (1960) showed the breed × pasture interaction to be significant for weaning weight but just short of significance for reproduction. The mean values for the two traits for the last five years are shown in table 2.

TABLE 2. AVERAGE PRODUCTION PERFORMANCE OF DIFFERENT BREED GROUPS OF COWS ON THREE PASTURE PROGRAMS FOR A FIVE-YEAR PERIOD 1957-1961

Trait and	Pasture		
Breed Group	Native	Combination	Improved
Weaning percent			
Shorthorn	60	64	60
Crossbred	66	75	76
Brahman	58	76	81
205-Day weight			
Shorthorn	235	323	363
Crossbred	370	439	456
Brahman	353	390	404

(2) Response to selection and genetic-environmental interaction in genetically similar groups of Hereford cattle at two locations (1186)

This is an interregional project cooperative between the Miles City, Montana Station, the U. S. Department of Agriculture, and the

Brooksville, Florida Station. Dr. E. J. Warwick serves as chairman of the Coordinating Committee which includes representatives from Montana, Florida, and the U. S. Department of Agriculture.

Two foundation herds were utilized in this study, including the Miles City Line 1 cattle and a Hereford herd established at the Brooksville Beef Cattle Research Station in Florida. The history of the Line 1 cattle is well known and will not be discussed here. The foundation animals for the Brooksville herd were obtained in Florida, Texas, New Mexico, Georgia, and Virginia. A few breeding age cattle were obtained in 1952 with periodic additions being made until 1959. Performance in the Brooksville herd was poor during the formative years with weaning weights of approximately 300 pounds and a weaning rate of 70 percent. All heifer calves were retained in the fall, with 10 percent being culled on the basis of weight as long yearlings. All nonpregnant females were culled each year with minor exceptions for cows with outstanding lifetime production records. In so far as numbers would permit, cows were culled, also, on the basis of death loss and weaning weight of calves. This culling amounted to approximately 20 percent of the cow herd annually. By 1962, when the herd was divided, production had increased to a weaning rate of 86 percent and a weaning weight of 438 pounds. The relative importance of genetic and nongenetic changes in bringing about this improvement is not known.

Reciprocal exchanges of cattle at the two stations were made from 1961 to 1963. Two groups of Line 1 cattle will be maintained at each station: (1) a closed herd selected for performance at that station, and (2) a check herd of the same genotype as the select herd at the other station. Similar genotypes in the two groups will be maintained by having the replacements for the check herd at one station and the select herd at the other station sired by the same bulls through the use of artificial insemination or transfer of bulls.

Thus, two tests for genotype-environmental interaction will be possible in this study; first, from the performance of the Brooksville and Miles City foundation stocks at the two locations, and secondly, from the performance of the Florida and Montana selections from Line 1. The former can be determined just as soon as temporary physiological adjustments have been made in the cattle which were exchanged. We can not be positive that this has occurred, however, until females born at the stations come into production. Results from the two selections from Line 1 cattle will require a long period of time. It should be a critical test of the importance of genotype-environment interactions in practical breeding operations, however.

The significant features of this project include the following:

1. Genotypic differences will be confined to those within a breed.

2. It is a long-term project making provision for the accumulation of any adaptive genetic changes that might occur so that they can be measured. The within-group genotypic

differences for specific adaptability which may exist in animals of one generation are in all likelihood too small to be detected successfully. For this reason, progeny testing of contemporary sires from the same population holds little promise as a definitive procedure for detecting genetic-environmental interactions. Directional accumulation of differences over a few generations, however, might result in significant differences that are measurable.

3. Control procedures have been designed whereby all stocks being tested will be born and reared at the location at which they are tested. This overcomes complications resulting from temporary physiological adjustments that occur when cattle are transported from one location to another.

The Brooksville cattle transferred to Miles City have performed at essentially the same level or below that of Line 1 cattle at Montana, depending on the trait considered. The Miles City cattle at Brooksville, like most other cattle introduced at the Station, have suffered a severe shock. Most of the problems encountered during the formative years of the Brooksville herd reappeared in the Miles City cattle introduced.

TABLE 3. AVERAGE PRODUCTION PERFORMANCE AT BROOKSVILLE, FLORIDA OF THE TWO FOUNDATION GROUPS DURING THE FIRST FOUR YEARS OF THE STUDY DURING 1962 THROUGH 1965[a]

Item	Group	
	Brooksville	Miles City
Calving rate - %	89.4	68.9
Calf survival - %	93.0	81.6
Weaning rate - %	83.1	56.2
Weaning weight - lbs.	443	391
Production per cow - lbs.	369	220
20-month wt. of heifers - lbs.	640	616
32-month wt. of heifers - lbs.	953	919
20-month wt. of bulls - lbs.	1093	1033
Fall weight, cow herd - lbs.	953	1070

[a]The results shown are preliminary only and should not be quoted as genetic differences. Except for six first-calf heifers in 1965, the Montana cow herd contained only animals born at Miles City and transferred to Florida. Evaluation of results must await comparison of animals born at the same station.

The average production performance of the two herds at Brooksville since the initiation of the project is summarized in table 3. The data will not be interpretable until temporary physiological adjustments have taken place. While final evaluation of the interactions of the two foundation groups with the two environments must await comparison of the production

performance of females born and reared at the station where tested, results to date would suggest that interaction will prove to be significant. The limited data from 1962 and 1963 heifers born at Brooksville support this indication.

The physiological reasons for the shock suffered by cattle introduced into Florida would be of extreme interest. The Florida station attempted to obtain information in this area with inconclusive results. The cattle have been tested for all diseases for which tests are available. Diseases of this nature have been negligible with no group differences being noticeable. Table 4 summarizes the data for certain blood constituents and liver copper. The liver copper levels are of interest because during the formative years of the Brooksville herd, as in the Miles City cattle introduced,

TABLE 4. AVERAGE VALUES FOR BLOOD CONSTITUENTS AND LIVER COPPER FOR BROOKSVILLE AND MILES CITY COWS AT BROOKSVILLE FROM NOVEMBER 1963 THROUGH OCTOBER 1965

Constituent	Group	
	Brooksville	Miles City
Blood:		
Hemoglobin, mg. %	11.2	11.6
Packed cell volume	38.4	41.7
Inorganic phosphorus, mg. %	5.3	5.3
Plasma calcium, mg. %	10.6	10.5
Total copper, mcg./ml.	.82	.85
Liver:		
Copper, ppm.	200	133

the visual appearance of numerous poor-doing animals was suggestive of copper deficiency. Copper deficiency was thought first not to be present because of blood copper levels and the fact that the mineral mix fed was heavily fortified with copper. The low liver copper levels recorded in the Miles City cattle introduced to Florida, however, suggest that even though blood copper levels were normal there may have been complications arising from low liver copper. Liver copper levels now have risen to normal in the Montana group, however, and there are still animals which have a visual appearance suggestive of copper deficiency. Laboratory results have yielded no other results suggesting a possible explanation of the poor performance of the Line 1 cattle at Brooksville.

Implications in Beef Cattle Breeding

On the assumption that genetic-environmental interaction may be an important consideration in beef cattle breeding, what should be the approach pending the outcome of critical test data? Two suggestions are offered:

(1) Breeding stock should be selected under much the same environmental conditions under which they will be utilized in commercial operations.

(2) Where animals must be transported from one environment to another, breeding animals, like stockers, should be moved from poor to good environment rather than the reverse, which is almost universally practiced. Animals bred under poor environment will tend to perform satisfactorily in most any environment, whereas the reverse is not true necessarily. This approach is supported in principal by selection experiments in swine (Fowler and Ensminger, 1960) and in mice (Falconer, 1952) as well as by practical experience and these preliminary results with beef cattle.

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Comments on S-10

Dr. Koger:

The major contribution of S-10 has been in crossbreeding, especially with Zebu cattle. We have observed some phenomenal heterosis in those cattle, but that phenomenal heterosis was not due so much to the good performance of the crossbreds as it was to the poor performance of the straightbreds. I believe there are a few interactions going on because we are able to improve the productivity of the British breeds, but we still get a high level from the Zebu-European crosses.

The other economic situation in the Southern Region is that we are working in a set of unfavorable circumstances or under an unfavorable environment that is entirely different from the unfavorable environment in these Western extremely dry regions. They are both unfavorable, but entirely different.

Some recent emphasis being placed in the Southern Region has not yet become a formal part of the regional project. For example, some of the most productive work in the Southern Region has to do with reproduction. We have just revised the S-10 project recently and studiously excluded any reference to reproduction in that project. But there are a number of interesting projects in the South dealing with physiology and genetic studies that are being made. We can look forward to some interesting data coming from these projects.

Another area beginning to receive emphasis in the Southern Region is the matter of death losses in calves. I don't know whether they are unusually high in the South or if we just know about our death loss more than in some other areas. But we are concerned about death losses in calves. How much is tied in to genetic factors and how much to environmental it is difficult to say. Probably both are involved. That is a project being studied at this time.

Another area is the overall efficiency of production--feed conversion. A number of stations are working on projects having to do with the influence of hybrid vigor, inherent size, and breed effects on feed conversion. These studies have a great deal to offer in helping us understand what is going on. I mentioned the hybrid vigor observed in some of the crossbreds in Florida. If we look at the rate of growth without hybrid vigor, that removes a little of our halo. We are not getting all of that growth for nothing. This is an area I think has a great deal to offer.

Another area of study deals with marketing cattle at a young age. A number of our states, three, in fact, are making a concerted effort to market 1,000-pound steers at a year of age. Florida, Texas, and Arkansas have projects. Texas is putting together some of the things they know about production to market 1,000-pound steers at one year of age, and they are marketing quite a few of them. But even in an environment as poor as Florida we have some crossbreds that at 13 months of age we are able to market at 1,000 to 1,050 pounds. In Florida we are doing it on roughage!

Another area is use of dairy cattle in crossbreeding work. None of these projects, or few of them so far, have been submitted as contributing to the regional project. (We get a few little experimental trials under way before we put them in as contributing projects.) But this goes along with marketing beef at a young age. I think that is the only area of crossbreeding left unexplored. This is an area we are going to move into.

Another area is genetic-environmental interaction studies. Florida is involved in a cooperative study with the U. S. Department of Agriculture in that state.

In the first place, we know genetic-environmental interactions exist. It is beyond reasonable doubt that they exist. And we can go a little further and say they exist in beef cattle. We can show significant genetic-environmental interaction if you want to cut across breeds and crosses. Contrary to the suggestion that Koger and Knox did not prove that there is no such thing as genetic-environmental interaction in cattle, we know it exists. The only question is what is the range in environment and genetics at which these interactions are important. That is the area we ought to be working on.

Since moving to Florida I have been kicking around this matter of these interactions a good deal and it seems to me it is interesting to speculate on the cause of some of these interactions before beginning to work with them.

The breeding men must get into action and do something worthwhile or their funds will be cut off. We have the best opportunity in the world of getting our teeth into this matter of genetic-environmental interaction. Frankly, we are just fiddling around doing nothing, really. All it would take is just a little bit of imagination and ingenuity to design an interregional project (the reason for regional projects is so we can have interregional projects). The same consideration that makes regional projects desirable makes interregional projects compelling.

I think this is a thing we need seriously to consider and I hope we can have an interregional meeting soon and do something about this. Industry is getting impatient with the restricted approach we are taking with some of our research work. If we expect to get the respect and cooperation of industry we must do something useful to industry and on a scale that will be of benefit to industry. We have a real good opportunity to set up some breeding projects that would answer the genetic-environmental interaction questions and be definitive.

Undoubtedly this project in Florida has generated more interest in the Southeast than all of the other breeding work in that area that has been done. As a matter of fact, reproduction and that project are all that industry people will talk about.

It has been a pleasure, Stony. I am sorry I have encroached on your time, but you can run over late tonight.

Discussion

Dr. Stonaker:

We appreciate your presentation. We do not intend to cut you off short, so now is the time for questions.

Why are you not satisfied with the Miles City-Brooksville project, and should we superimpose some others of this kind?

Dr. Koger:

I think it is a good project, but it is too narrow in scope to answer all the questions that need answering. A good interregional project would not detract from this Miles City-Brooksville project at all.

Dr. Stonaker:

The results on the Brooksville-Miles City work are very striking and I would say it is just a result of moving a bunch of cattle.

Dr. Koger:

Yes, but I don't feel we can say that with what information we have. We have two groups of females now that have reached reproductive age. There are differences now and the situation is going to get worse for the Montana cattle. They have not attained the growth of the Montana cattle shipped down there.

Dr. Warwick:

For the other side of the coin, the differences at Miles City are not so great but the Montana cattle are better than the Florida cattle.

Dr. Cobb:

Why was reproduction left out of the S-10 project?

Dr. Koger:

It isn't in there. I don't know.

Dr. Warwick:

Reproduction as affected by genetics, heterosis, and breeding techniques is there along with other genetic measurements. Physiology of reproduction per se is a separate subject and therefore should not be put in that particular project.

Dr. Stonaker:

Would you want to give us a few indications of results of the extra projects being carried on not formally in the project outline, such as cooperative dairy and beef projects?

Dr. Koger:

Crossbred cows having some dairy breeding in them are weaning a lot heavier calves than anything we have been able to compare them with. They are heavier than the Zebu crosses. There are no problems having to milk out the cows on the pasture in any of the work that I know of. In terms of weaning weight, there is about 100 to 150 pounds advantage over crossbreds of British breeds. Most of the crosses so far have been with Brown Swiss, but there has been some interest shown in Holsteins and I think they may have more potential than some of these other cattle. There are no Jersey crosses that I know of, but some commercial people like to use cows with a little Jersey breeding in them.

Dr. Blackwell:

What about the potential for a new breed with some dairy breeding in them?

Dr. Koger:

That is another area where the beef cattle breeders might come up with an effort on a large enough scale that it would be worthwhile. I think we need another breed or two in this country. We may lose one or two of those we have.

Dr. Stonaker:

What happened to the Dual-Purpose Shorthorn, Everett?

Dr. Warwick:

They are still at the Minnesota station on a small scale. That is one of the breeds going down hill.

Dr. Koger:

The best method may be to use the cattle we have and correct their deficiencies.

Dr. Cobb:

What about the use of crossbred bulls? I heard about that in the South.

Dr. Koger:

There are going to be some people trying some crossbred bulls.

STATION REPORTS

UNIVERSITY OF ARIZONA

I. Station: Arizona Agricultural Experiment Station, Tucson

II. Project title: (1) Breeding and selection of beef cattle for the Southwest. (2) Progeny testing of selected Hereford sires.

III. Personnel:

Experiment Station:
C. B. Roubicek, Project Leader, L. W. Dewhirst, A. M. Lane, D. E. Ray, and B. R. Taylor

Graduate Students:
R. L. Taylor and T. O'Kane

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

Cooperators:
Apache Indian Agency and Apache Tribe, San Carlos, Arizona
W-1 cooperating stations

IV. Nature and extent of work done this year:

1. Continued collection of data as outlined in project plans.

2. The second breeding season of the line-test program proceeded on schedule. In addition to the 10 replacement sires, Utah 0119 and Wyoming 71 will be used this year for the second time.

3. The analyses of blood and liver data are continuing. The development of a suitable computer program proved to be more of a problem than was anticipated.

4. Approximately 150 of the nonregistered Hereford cows will be bred by AI to two sires from the Armour BCI stud. We plan to include these cows and progeny in our regular data collection program.

VII. Work planned for the future:

In addition to the registered Hereford herd, the San C-rlos tribal herd also includes about 500 nonregistered Hereford cows. These are completely comparable to the registered herd except that registration was discontinued on these animals.

The nonregistered herd is range-bred to bulls that have been used in the registered herd or are of similar breeding to those used in the registered herd. We are considering the possibility of expanding the San Carlos project to include progeny performance data from the nonregistered herd and

Summary of Individual Data on Regional Bulls Used at Arizona During the 1966 Breeding Season

Name and Origin of Bull	Tattoo and Registration number	Birth weight Act.	Birth weight Dev.	Weaning weight Act.	Weaning weight Dev.	Adjusted weaning weight Act.	Adjusted weaning weight Dev.	Daily gain on test Act.	Daily gain on test Dev.	Feed efficiency Act.	Feed efficiency Dev.	Days on test Act.	Days on test Dev.	Final weight off test Act.	Final weight off test Dev.	Age off test Act.	Age off test Dev.
MSC Clay's Supreme 44	220																
Bozeman, Montana	12167912	79	0	461	55	421	29	2.19	.12	6.94[1]	.59	140	0	786	70	360	3
L4 Mischief 121	1050																
Miles City, Montana	11938020	81	0	408	40	413	32	2.70	.13	22.08[2]	-.93	196	0	938	54	407	17
L14 Mixer 110	3032																
Miles City, Montana	12771055	80	-6	522	37	464	0	2.93	.16	Group fed		196	0	1115	83	414	14
NMSU 413	413																
New Mexico	13280049	89	12	520	-1	517	-7	2.93	.20	392[3]	-84	140	0	1000	-10	449	-4
USU Advance Lad 0133	0133																
Utah	13012017	91	7	460	-17	494	26	2.73	.35	6.25[1]	-1.14	112	-3	919	5	419	-9
Reno E 310	684																
Reno, Nevada	12736458			495	23			1.95	.26	20.50[2]	1.7	140	0	775	53	398	6
KC E 210E	K333																
Knoll Creek, Nevada	12215589			420	-13			1.45	.38	21.70[2]	5.3	140	0	615	37	392	1
Royal 3164	3164																
Colorado	12795137			405	48	487	49	3.08	.20	8.25[1]	.50	140	0	1129	74	550	-12
Brae Arden 1124	1124																
Colorado	11784651			370	20	533	58	2.51	.23	6.00	-1.27	140	0	708	40	378	-24
Gillette Arden 37	152																
Wyoming	12109522	84	6	455	40	428	31	2.47	.26	Group fed		168	0	880	80	371	4

[1] Feed/lb. gain - lower value is superior
[2] Lb. gain/cwt. TDN - higher value is superior
[3] TDN/cwt. gain - lower value is superior

in addition to individually evaluate the entire cow herd. This proposed project is included as a separate report for committee comments and discussion.

IX. Project summary:

Arizona Agricultural Experiment Station

Cattle Inventory - June 1966			Total
Breed	Hereford	Hereford	
Purebred or grade	Purebred	Grade	
Bulls (12 mo. or over)	170		170
Cows (2 yr. or over)	473	63	536
Heifers (yearlings)	172		172
Calves - bulls	151		151
- heifers	176		176

Cow Production Data - 1965 Calf Crop		
Number cows bred to calve:		
As 3-yr.-olds and up	413	413
Number calves born:		
From 3-yr.-olds - alive	352	352
and up - dead	4	4
Number calves weaned	327	327
Percent calf crop[a] - born	85.2	85.2
- weaned	79.2	79.2

$^{a}\dfrac{\text{Calves born alive}}{\text{Cows bred}}$

Preweaning Performance - 1965 Calf Crop	Bulls	Heifers
Birth weight	78	73
Weaning age	247	244
Weaning weight	478	452
Adjusted weaning weight[b]		
Weaning score:		
Conformation	11.4	11.8
Condition	10.9	11.3

[b]Not computed

UNIVERSITY OF CALIFORNIA

I. Station: California Agricultural Experiment Station, Davis

II. Project title: Studies of heterotic effects in crosses of the Angus, Hereford, and Shorthorn breeds (Project 1216)

III. Personnel:

Experiment Station:
W. C. Rollins, Project Leader, F. D. Carroll, R. G. Loy, Allan Grunder, Moira Tanaka, and K. A. Wagnon

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. and V. Nature and extent of work done this year and summary of progress and conclusions to date:

The experiment proceeded according to plan.

(a) Percentage of cows exposed to bull that carried a calf to term showed hybrid vigor of 16, 18, and 14 percent, respectively, for the Angus × Hereford, Angus × Shorthorn, and Hereford × Shorthorn crosses.

Over the three breeding seasons Angus, Hereford, and Shorthorn cows, respectively, averaged 77, 76, and 60 percent for this trait.

(b) Preliminary estimates of parameters for gestation length and birth weight

	Gestation length days		Birth weight pounds
Overall average	285.0		63.3
Sex difference male - female	0.13±.092*		2.40±1.49
Regression of GL on BW		0.32±0.05	
Regression of BW on GL		0.74±0.13	

Reciprocal cross	Heterosis** GL (days)	Heterosis** BW (lbs.)		Breed comparison GL (days)	Breed comparison BW (lbs.)
A × H	1.12±1.59	-.03±2.49	A - H	-5.96±3.18	-15.25±4.99
A × S	0.00±1.91	0.11±2.51	A - S	0.65±3.79	-2.69±4.99
H × S	1.47±1.29	4.37±2.62	H - S	7.25±2.54	19.32±5.17

*Standard error

**If positive, average of crossbreds exceeds average of straightbreds

(c) Weaning weight and postweaning growth of second calf crop (sired by Hereford bulls)

See tables 1 and 2

TABLE 1. PERFORMANCE COMPARISONS OF HA AND HS CROSSBREDS WITH HH STRAIGHTBREDS

	Overall average	HA-HH	$\frac{(HA-HH)\times 100}{HH}$	HS-HH	$\frac{(HS-HH)\times 100}{HH}$
			percent		percent
205-day weaning weight	420	26	6.6	56	14.1
Weaning grade	87	0	0	0	0
Postweaning gain:					
Bulls and steers in feedlot	475	-23	-4.6	-59	-11.8
Heifers in drylot at Davis	227	17	8.4	55	27.1
Heifers on range	70	2	2.9	13	19.1
Age-adjusted yearling weight:					
Bulls and steers in feedlot	909	-15	-1.6	-9	-1.0
Heifers in drylot at Davis	581	42	8.0	134	25.7
Heifers on range	435	30	7.2	20	4.8

TABLE 2. PERFORMANCE COMPARISONS OF BULLS WITH STEERS

	Overall average	Bulls-Steers	$\frac{(Bulls-Steers)\times 100}{Steers}$
			percent
205-day weaning weight	434	76	19.2
Weaning grade	87	0	0
Postweaning gain	475	47	10.4
Age-adjusted yearling weight	909	123	14.5

VI. Application of findings:

Too early to report

VII. Work planned for the future:

At Davis the three planned breeding seasons have been completed. The third calf crop is being grown out. Range breeding continues.

A new breeding project at Davis dealing with muscular hypertrophy is being designed. There is a mutant gene in domestic cattle that causes easily discernible changes in form primarily due to muscular enlargement but, also, to reduction in the amount of subcutaneous, extramuscular, and intramuscular fat, thinning of the hide,and possibly some modification in the skeleton.

This gene has been found in all cattle breeds but is scarce in most.

It is of relatively high frequency in the Charolais breed where it appears to tend toward dominance. This means that the condition may sometimes be spotted in heterozygotes in slight manifestation in addition to strong manifestation in the homozygotes. Among the British breeds the gene turns up more often in Angus than in Shorthorns or Herefords and its dominance or recessiveness is not clear.

The mutant phenotype (sometimes called the double muscle condition) can be described as follows: From birth to maturity there is excessive muscle development, especially in the hind quarters, associated with reduced subcutaneous fat and thinning of the hide, all in concert, giving rise to visible intermuscular grooves particularly in the outside of the thigh. Also, the shape of the rump tends to resemble that of a Quarter horse. In fact, in Italy the condition is called "horse rump" by breeders instead of "double muscle" as in this country.

Preliminary phenotypic studies, test matings, and pedigree and progeny studies are currently under way at Davis to devise a grading system (based on visible intermuscular grooves and rump shape) for phenotypically detecting the presence of the mutant gene in the heterozygote. In the project under design it is hoped to correlate such a system with extensive carcass and offal measurements and progeny and pedigree information.

The literature and some of our own data indicate that this gene significantly increases the lean to fat and lean to bone ratios. Hence, it could be of great value to the beef industry provided no unmanageable, undesirable side effects exist. There is some evidence that the gene, especially in homozygous form, might lead to parturition problems. Also, little is known about the eating and keeping quality of the meat. Experience in Italy shows that it might be practical to use homozygous mutant bulls on large, roomy normal cows and market the heterozygous calves.

The project being designed will attempt to throw light on the above considerations and work out a system for phenotypically identifying the presence of the gene in the live animal so that the gene could be "plugged" "into" or "out of" breeding operations when and where desired.

VIII. Publications and manuscripts:

Carroll, F. D. 1966. Inspection of Angus, Hereford, and Shorthorn cows with crossbred calves at side. Beef Cattle Day. Animal Husbandry Department. Univ. of Calif. pp. 34-35.

Rollins, W. C. 1966. Research results on the Angus-Hereford cross. Beef Cattle Day. Animal Husbandry Department. Univ. of Calif. pp. 4-12.

Wagnon, K. A., R. G. Loy, W. C. Rollins, and F. D. Carroll. 1966. Social dominance in a herd of Angus, Hereford, and Shorthorn cows. Animal Behavior. (In press.)

IX. Project summary

California Agricultural Experiment Station

Cattle inventory										Total
Breed	Angus	Here-ford	Short-horn	Crossbreds AH	AS	HA	HS	SA	SH	
Purebred or grade	Purebred			Grade						
Bulls		2*								2
Cows	21	21	23							65
Calves			11					16	16	43
Yearlings		13				17	11			41
Two-year olds	9			15	7					31

*Vasectomized

REPORT OF CALIFORNIA STATION PROJECT 1451

formerly cooperative with W-1
but terminated May 29, 1964

P. W. Gregory

Present Status of Research

The studies of bovine achondroplasia during the past six decades indicate there are many different types, some reported inherited as dominants such as Dexter, comprest, and compact. Others reported inherited as recessives and reasonably well described include the Telemark monster, the short-headed dwarf, the long-headed dwarf, stumpy, and numerous others from many countries. Reports of a mutant appearing in herds where there is little genetic interest consistently suffer from incompleteness, lack of sophistication, and integration. This accounts for the existing chaotic state of the genetic and biological knowledge.

During the past 16 years at this laboratory more than 35 different matings were made between the micromelic "dominant" mutants, compact and comprest, and recessive types including stumpy, both short-headed and long-headed dwarfs, and controls of conventional size but dwarf-producing stock, in an effort to determine how each micromelic stock is related to the others.

From the matings of micromelic non-Dexter stocks, animals resembling Dexter were obtained in several different ways. Dexters were introduced to determine if the Dexter-like segregates could produce all the components of the Dexter complex, and the results were positive. All three classes, Kerry, Dexter, and Dexter "bulldog", have been reconstituted. Dexter mated to the short-headed dwarf produced the Dexter type, which was confirmed by a progeny test, and a larger class as yet unclassified. Dexter mated to comprest resulted in the reconstitution of the short-headed dwarf, Dexter, and animals yet to be classified. The mating of Dexter to long-headed dwarf produced Kerry-like animals that breed as Kerry.

There is ample proof that the Hereford, Angus, and Shorthorn breed each possesses the potentiality to produce all of the Dexter components, but the type of selection practiced favors other than the Dexter type of achondroplastic deterioration. The assumed "dominance" in the Dexter components seems to be a simulated effect arising from a peculiar interaction of the major achondroplastic recessive gene in the homozygous state with alleles at two other loci which act as modifiers, but difference between dominance and factor interaction escapes detection if all members of successive generations are examined superficially or there is incorrect classification.

It is unlikely that there are two loci, one carrying a dominant gene and another carrying a recessive conditioning gene, each conditioning achondroplasia. The evidence indicates that the major achondroplastic gene is recessive and the patterns and degrees are determined by modifying genes at two or more other loci. The dominant allele of the major

achondroplastic conditioning gene has been sought in many stocks, but thus far all tests have been negative--perhaps it was lost with the extinction of the Auroch. As the results were being analyzed and interpreted, it was evident that there was a missing "link" in the chain of related mutants necessary for a tenable genetic solution. This difficulty seems to have been surmounted with the segregation of two Telemark monsters from critical matings indicating that Dexter, Telemark, and comprest are related, and both the Telemark lethal and Dexter "bulldog" are related, and both are multiple recessive forms. This does not agree with Punnett's conclusions that the Dexter "bulldog" and the recessive Telemark monster are independent (J. Genetics 32:65), but it is obvious now his data lacked sufficient progeny for a definitive test.

Many components that compose the genetic micromelic types are well enough defined now to attempt fitting all the related mutants into a hypothetical scheme of inheritance. Mr. C. D. Scott, a graduate student in cytology and a recently appointed trainee of The National Institute of Health Program in Genetics, TIGM 701-06, investigated a peculiar bovine intersex placed at his disposal and found it was a unique trisomic XXY/XX related to Klinefelter's syndrome in man. He is making a detailed cytological study of all specific types of achondroplastic mutant stocks. He is also investigating other types of bovine intersexes and in each case the disciplines of genetics, cytology, immunogenetics, and pathology are integrated; Dr. C. S. Stormont is doing the immunogenetics and Dr. Peter C. Kennedy the pathology. None of the funds allotted for achondroplasia are or have been diverted to the study of intersexes, but the cytological study would not be possible without the grant.

Summary of Proposed Work

Matings to classify the specific genetic interrelationships of the different micromelic types within the system will continue. The reconstitution of more Telemark lethals among F_1 progeny from mating Dexter with comprest Herefords is desirable and will be attempted. Attention also will be directed to the biological and genetic analysis of the Kerry--how it exerts its influence and its genetic relationship to other components of the system. Attention will be directed to genetic interaction of alleles in the stocks that cause 1) specific types of achondroplastic deterioration on the one hand and, 2) the reconstitution of the Telemark monster among F_1 progeny from mating registered Dexters to comprest Herefords, 3) an analysis of F_1 progeny produced by reciprocally mating short-headed with long-headed dwarfs, and 4) standard metacarpal indices for achondroplastic dolichocephalic dwarfs. Also planned are two or more reports integrating immunogenetics, cytology, and pathology of bovine intersexes, which will include a more plausible hypothesis to account for the sterility of the female born twin to a male.

Achondroplastic herd inventory - June 1, 1966	Number	Total
Brachycephalic dwarfs		
Females	19	
Males	1	20
Dolichocephalic dwarfs		
Females	17	
Males	1	18
Comprest - all types		
Females	24	
Males	2	26
Dexter - Kerry types		
Females	40	
Males	3	43
Unclassified types		
Females	3	
Males	2	5
Weaner calves (7 to 12 months)	54	54
Total		166

COLORADO STATE UNIVERSITY

I. Station: Colorado Agricultural Experiment Station

II. Project title: Study of selection, inbreeding, and the crossing of inbred lines within the Hereford breed (R & M 26)

III. Personnel:

Experiment Station:
H. H. Stonaker, Project Leader, Kent Riddle, Tom Hall, and Glenn Richardson

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year:

A. Calf losses:

The M. S. thesis submitted by Larry Theurer has shown that over 60 percent of all deaths occurred at calving or within 24 hours. Major causes of death from birth to weaning were: born dead or died within 24 hours following birth, 30.8 percent; died of unknown cause after first 24 hours, 16.1 percent; premature calves, 10.4 percent; dystocia, 8.6 percent; cold and exposure, 5.7 percent; pneumonia, 4.7 percent; various miscellaneous causes, 23.7 percent. More males than females were born dead or died within 24 hours. However, there were more dystocial cases in females. Sex differences appeared for all the various causes but were nonsignificant. Linecross Herefords were found to have lower death losses than crossbreds, controls, or inbreds.

B. Breeding soundness in yearling bulls:

In the M. S. thesis submitted by James McNitt, very low heritabilities were obtained for estimated breeding soundness, semen quality, score, vigor, percent alive, and morphology. However, large amounts of heterosis were found when linecross bulls were compared to inbred bulls. Linecross bulls and crossbred bulls were superior to all other bulls in morphology of sperm cells. It was suggested that the testicular environment given the sperm cell may be leading to differences in cell division which in turn contribute to poorly shaped sperm.

C. Nuclear morphology of spermatozoa:

Through the cooperation of Dr. G. W. Salisbury and Dr. F. N. Baker of the University of Illinois, a study of nuclear abnormalities due to disturbances in spermatogenesis was conducted on 80 inbred and linecross Hereford bulls. Significant sire differences were found in the proportions of normal, pyriform, unevenly stained, and diploid sperm nuclei in the semen of their sons. Except for diploid nuclei (which were rare) the linecross sons excelled the inbred sons on the average, but not significantly so.

D. Carcass traits of cows:

Carcass data from surplus and aged cows were analyzed in the M. S. thesis prepared by Martin Kyomo. It was found that inbreeding had a depressing effect on palatability of steaks. Age had little or no effect on palatability factors of mature cows. However, tenderness was found to decrease with age up to maturity.

E. Genetic and environmental interactions:

A study of genetic and environmental interactions affecting weaning weights of Hereford calves is under way. Purpose of this study is to obtain more critical information on the relative importance of interactions in weaning weight data, thereby permitting development of appropriate mathematical models to investigate factors influencing weaning weight with greater precision.

F. Carcass characteristics of bulls and heifers:

Carcass data are being collected to continue this study. The data collected over the past three years are being analyzed to determine genetic and phenotypic parameters of both quantitative and qualitative carcass traits. Much of the study is centered around a rather detailed retail cutout, organoleptic evaluation, and chemical analysis on each animal. The effect of mating system upon these carcass characteristics is of particular interest.

G. Milk and feed consumption of inbred and hybrid beef calves versus dairy calves:

This is the third year of a study to explore effects of mating systems and breed on efficiency and rate of growth and carcass characteristics. Calves on this study come from heifers on the milking trial and are individually hand raised. In addition, a few dairy calves of Holstein breeding are raised as contemporaries with the beef calves.

H. Milk production of inbred and hybrid beef heifers:

The study concerning effects of the mating system and line of breeding on milk production is in its third year. First calf Hereford heifers (2-year-olds) are milked twice daily to obtain production records and chemical analysis of the milk.

I. Weaning characteristics of inbred and hybrid and crossbred calves:

Routine weights and grades of calves from various mating

systems and lines of breeding are being continued as in the past.

J. Performance of cooperator-raised cattle:

There is a continuation of the feedlot performance of unselected bulls from the San Juan Basin Station and of a number of bulls provided by breeders in the San Juan Basin region. Two groups of bulls are tested annually. The first group of cattle are placed on a high level of energy rations following weaning, and in the second group the bulls are wintered on a high roughage ration and subsequently in June are placed on high energy rations for a 140-day period.

K. Progeny testing on the San Carlos Reservation and in the Hawaiian Ranch Company herds:

Through the cooperation of the University of Arizona and the University of Hawaii, the San Juan Basin Experiment Station is providing two bulls annually for progeny testing in these herds. This is being done under the direction of the Regional Coordinator, Dr. J. S. Brinks.

L. Fat characteristics:

An analysis of lipids and fatty acids on slaughter cattle from the various lines has been initiated in a cooperative study with other stations in W-1.

VIII. Publications and manuscripts:

Kyomo, Martin L. 1966. Carcass characteristics of Hereford cows. M. S. Thesis. Colorado State University. Fort Collins.

Kyomo, M. L., H. H. Stonaker, K. Riddle, D. A. Cramer, and G. Richardson. 1966. Carcass characteristics of Hereford cows. Amer. Soc. Anim. Sci. West. Sect. Proc. 17:163-168.

McNitt, James I. 1965. Genetic aspects of estimated breeding soundness of beef bulls. M. S. Thesis. Colorado State University. Fort Collins.

McNitt, James I., H. H. Stonaker, and E. J. Carroll. 1966. Estimating breeding soundness in beef bulls. Amer. Soc. Anim. Sci. West. Sect. Proc. 17:25-30.

Salisbury, G. W. and F. N. Baker. 1966. Nuclear morphology of spermatozoa from inbred and linecross Hereford bulls. J. Anim. Sci. 25:476.

Theurer, Larry J. 1965. Beef calf losses as influenced by mating system, sex, and age. M. S. Thesis. Colorado State University. Fort Collins.

IX. Project summary:

Colorado Agricultural Experiment Station

Cattle Inventory - June 1966					Total
Breed	Hereford	Hereford	Hereford	HxS-A	
Line	Inbred	Linecross	Control	X-bred	
Purebred or grade	Purebred	Purebred	Purebred	Grade	
Performance test bulls:					
Winter	20	43	6	2	71
Summer	25	17	8	2	52
Herd bulls	18	4	1	0	23
Cows (2 yrs. or over)	105	140	16	7	268
Heifers:					
Replacement yearlings	25	11	1	0	37
Feedlot	9	44	6	0	59
Calves - Bulls	42	66	3	4	115
to May 25 - Heifers	39	60	4	3	106

Cow Production Data - 1965 Calf Crop					Total
Number cows bred to calve:					
As 2-yr.olds	17	19	4	0	40
At 3 yrs. and up	103	121	18	7	249
Number calves born from:					
2-yr.olds - Alive	12	14	4	0	30
- Dead	2	0	0	0	2
3-yr.olds and up - Alive	69	111	17	5	202
- Dead	6	4	1	2	13
Number of calves weaned	73	121	20	5	219
Percent calf crop[a] - Born	74.2	92.1	95.5	71	80.3
- Weaned	90.1	96.8	95.2	100	94.4

Preweaning Performance - 1965 Calf Crop					Average
Heart girth at birth (cms.) - Bulls	70.6	74.2	73.7	76.5	73.1
- Heifers	67.6	73.6	73.8	(1) 76.0	71.0
Weaning age - Bulls	200	203	193	211	201
- Heifers	203	203	199	(1)152	202
Weaning weight - Bulls	392	466	403	601	441
- Heifers	402	424	388	(1)385	413
Adjusted[b] weaning weight - Bulls	448	473	423	572	463
- Heifers	450	458	422	(1)515	454
Weaning score:					
Conformation - Bulls	4.5	5.1	5.0	5.5	4.9
- Heifers	4.8	5.0	5.0	(1) 5.0	4.9
Average inbreeding - Bulls	0.43	0.0	0.0	0.0	
- Heifers	0.35	0.0	0.0	0.0	

Postweaning Performance - 1965 Calf Crop					Total
Breed	Hereford	Hereford	Hereford	H×S-A	
Mating system	Inbred	Linecross	Control	X-bred	
Sex	Bull	Bull	Bull	Bull	
Method of feeding		Individual			
Number on test	18	44	6	2	70
Average age on test	267	266	270	280	267
Initial weight	445	504	471	643	490
Days on test	140	140	140	140	140
Average daily gain	2.62	2.78	2.70	3.18	2.74
Feed efficiency: TDN/100 lb. gain	730	690	699	753	703
Final weight	806	892	850	1089	872
Final score	4.4	4.8	4.9	5.6	4.7
Average inbreeding	0.45				

[a]Percent calf crop - Born $= \frac{\text{total births}}{\text{total bred}}$

- Weaned $= \frac{\text{live births}}{\text{number weaned}}$

[b]Adjusted weaning weight - correction after Harwin Model 3

		Bulls	Heifers
Inbreeding of dam	add	0.78 lbs.	0.79 lbs. per 1% inbreeding of dam
Inbreeding of calf	add	0.41 lbs.	0.24 lbs. per 1% inbreeding of calf
Age of dam:			
2-year-old	add	55.0 lbs.	63.0 lbs.
3-year-old	add	20.0 lbs.	36.0 lbs.
4-year-old	add	14.0 lbs.	15.0 lbs.
5-year-old +		No correction	

COLORADO STATE UNIVERSITY

I. Station: Colorado Agricultural Experiment Station, Fort Collins, and United States Department of Agriculture, Agricultural Research Service, Animal Husbandry Research Division, Fort Collins, Colorado

II. Project title: The heritability of various components of serum lipids and their relationship to the composition and distribution of fat in beef cattle (Project 28)

III. Personnel: D. A. Cramer, Project Leader, L. G. Miller, and J. S. Brinks

IV. Nature and extent of work done this year:

Blood serum and 12th rib cuts have been obtained from the cattle slaughtered by the California, Colorado, Hawaii, Montana (Bozeman, Havre, and Miles City), New Mexico, and Washington stations. Percent intramuscular fat in the longissimus dorsi muscle has been determined and iodine numbers (IN) have been obtained on subcutaneous and intramuscular fats. The fats presently are being prepared for fatty acid analysis by gas chromatography.

Techniques have been worked out for the analysis of various fatty constituents of blood serum by thin layer chromatography coupled with gas chromatography and serum lipid analysis is now under way.

As a preliminary step in blood serum analysis, five heifers were bled four hours after feeding and again twelve hours after feeding. After a lapse of one day the blood collections were repeated, giving four samples of serum from each heifer. The amounts and composition of each class of lipids were determined to ascertain the effect of time of collection on the variability of serum lipids (tables 1 and 2).

Table 1. Total Serum Lipid
Five San Juan Heifers Bled Four Times

Heifer number	September 21, 1965 4 hours postfeeding	September 21, 1965 12 hours postfeeding	September 23, 1965 4 hours postfeeding	September 23, 1965 12 hours postfeeding
	mg.%	mg.%	mg.%	mg.%
4445	360	335	205	665
4571	365	380	500	640
4669	345	415	480	535
4673	390	400	580	325
4681	465	435	210	250
Average	385	393	395	483

Overall average for 47 heifers - 353.6 ± 129.7 mg.%

Table 2. Fatty Acid Composition of Serum Lipid Fractions of Eight San Juan Heifers

	C12	C14	C14:1	C16	C16:1	C18	C18:1	C18:2	C20	Total[a]
Total lipid	2.0	1.5	2.8	15.0	5.9	14.7	13.0	28.5	3.1	86.5
Tri-glycerides	2.7	5.0	6.0	17.6	4.4	19.5	16.9	15.5	-	87.6
Phosoho-lipids	8.5	6.5	6.3	13.6	3.3	16.0	13.5	18.4	4.2	90.3
Free fatty acid	5.0	4.2	4.2	12.7	4.8	14.8	11.3	21.7	5.3	84.0
Cholesterol esters	6.3	6.2	6.0	14.1	5.7	13.4	15.4	27.2	-	94.3

[a]The remaining 5 to 15 percent are short chain or unidentified acids.

V. Summary of progress and conclusions to date:

The data accumulated to date are presented in table 3. Means and standard deviations are listed by sex, breed, and station. There appears to be an environmental station difference in that the fat from cattle fed at stations with colder climates (i.e., Bozeman and Havre) have higher average IN than the other stations.

The California data indicate that there is no difference in fat composition between bulls and steers but the Colorado data show a possible difference in IN of subcutantous fat between bulls and heifers within the Hereford breed. Breed differences are probably nonsignificant. There is a slight difference in subcutaneous fat IN among nutritional treatments in the New Mexico cattle but the intramuscular fat IN and percent rib-eye fat are essentially the same.

Intramuscular fat is probably largely glycerides and nonsaponifiable compounds when obtained by conventional ether extraction and may not contain appreciable amounts of phospholipids. The intramuscular fat IN in table 3 substantiate this line of reasoning and also point out that the intramuscular glyceride structures are quite similar to subcutaneous glycerides. On the other hand, phospholipid fatty acids are quite different from glyceride fatty acids. Phospholipids may have been overlooked as important contributors to flavor of beef. This thought will be given consideration when the muscle and serum lipids have been further fractionated and analyzed.

Although reports in the literature suggest that IN of fat from ruminants increase as the animals fatten, the correlations between the fat IN and percent rib-eye fat are quite low (r = .22 and -.21,for subcutaneous fat IN and intramuscular IN, respectively, correlated with percent rib-eye fat). A high correlation of this type would probably exist only if cattle are fed fairly large amounts of fat. The slower gaining cattle would absorb and deposit highly saturated dietary fat and the more efficient cattle would be laying down a more unsaturated endogenous fat.

Table 3. Means and Standard Deviations of Percent Rib-eye Fat and Iodine Number of Fat from W-1 Beef Cattle

		California					
		Hereford		Hereford-Angus		Hereford-Shorthorn	
		Bull	Steer	Bull	Steer	Bull	Steer
	N	2	2	5	3	3	2
Subcutaneous fat Iodine number	$\bar{X}$	47.120	47.075	48.892	48.743	47.440	48.000
	σ	0.9051	3.4436	3.4275	1.6553	0.6255	1.2445
Intramuscular Iodine number	$\bar{X}$	49.405	47.585	46.998	46.397	47.973	45.835
	σ	1.8880	3.2598	2.5387	1.6878	1.0078	1.1243
Intramuscular Percent fat	$\bar{X}$	17.300	19.015	20.036	24.913	18.773	25.090
	σ	0.3111	4.3204	5.3492	4.3240	3.9118	5.5154

		Colorado					
		Hereford			Hereford-Angus		
		Bull	Bull	Heifer	Bull	Bull	Heifer
		Spring	Fall		Spring	Fall	
	N	21	18	38	2	2	4
Subcutaneous fat Iodine number	$\bar{X}$	44.515	47.414	50.247	48.575	50.825	50.028
	σ	2.3791	2.1534	2.5515	2.8991	2.7082	4.0674
Intramuscular Iodine number	$\bar{X}$	49.193	48.572	48.912	44.650	48.630	47.483
	σ	2.2244	1.6174	1.5757	2.9981	1.2208	1.5733
Intramuscular Percent fat	$\bar{X}$	8.029	11.088	22.426	10.675	12.580	29.543
	σ	2.9468	2.8662	4.5517	1.7388	0.2504	4.1379

		Montana	Miles City	Havre	New Mexico			Washington
		Hereford	Hereford	Hereford	Hereford			Angus
		Steer	Bull	Steer	Steer	Steer	Steer	Bull
					Lot 1	Lot 2	Lot 3	
	N	7	29	28	10	9	10	11
Subcutaneous fat Iodine number	$\bar{X}$	52.264	48.435	52.463	48.277	47.007	46.679	48.715
	σ	2.6910	2.4617	2.4335	1.7662	1.9843	1.4215	3.4572
Intramuscular Iodine number	$\bar{X}$	51.391	52.969	52.530	46.871	46.189	47.404	46.823
	σ	2.7920	2.1007	2.1665	3.6574	2.2254	2.1760	2.5896
Intramuscular Percent fat	$\bar{X}$	32.567	18.111	17.037	20.341	19.626	19.104	22.286
	σ	4.6424	8.7944	4.1449	8.2374	10.2230	7.6955	7.4158

Sire differences in IN of both subcutaneous and intramuscular fat were significant ($P < .05$) in an analysis of variance within stations, breeds, seasons, treatments, and sex. Differences in percent rib-eye fat between sire groups were nonsignificant.

VI. Application of findings:

As this project is in a preliminary stage, sufficient data have not been collected to formulate any application of findings except as the results thus far contribute to the general knowledge of fat metabolism in beef cattle.

VII. Work planned for the future:

The tissues collected from the cattle slaughtered in 1965 will undergo further analysis. Fatty acid composition of subcutaneous fats will be determined. The fats of *longissimus dorsi* extracts and blood serum will be separated into lipid classes. Each class of lipids will be quantitated and analyzed for fatty acid composition.

Blood serum and 12th rib cuts will be collected from the W-1 contributing projects when the cattle are killed in 1966. The same analyses will be carried out on the 1966 tissues that are planned for the 1965 tissues.

After analysis of two years' data, the results will be reviewed and used as a guide in directing future studies on the genetic aspects of fat metabolism in beef cattle and the distribution of fat in the beef carcass.

UNIVERSITY OF HAWAII

I. Station: Hawaii Agricultural Experiment Station, Honolulu

II. Project titles: The estimation of genetic and phenotypic parameters in populations of beef cattle in Hawaii and their use in selection programs.

A study of heterosis from crosses among breeds of beef cattle.

III. Personnel:

Experiment Station:
Estel H. Cobb, Project Leader, Oliver Wayman, Isaac I. Iwanaga, Kiyoichi Morita, Diedrich Reimer, and Richard Indrieri

Hawaiian Ranch Company:
Tom Liggett and Carl Bredhoff

Kahua Ranch Company, Ltd.
H. M. Richards

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. and V. Nature and extent of work done this year and summary of progress and conclusions to date:

Weights and grades on the 1965 calf crop were obtained as scheduled. The progeny testing of the 1964 calf crop was finished during the year. Five years of data on progeny testing are now available for analysis. The average performance for all but three of the 1964 animals has been summarized and is presented in the project summary.

The testing of inbred lines in cooperation with the Arizona station was continued this year. One hundred fifty five cows were bred by artificial insemination to MSC Clay's Supreme 44, L4 Mischief 121, KCE 210E, Royal 3164, and Bay Tontine 27 (International Beef Breeders bull) at Hawaiian Ranch Company. These are the same lines used the first year with the exception of the Bay Tontine 27 bull. Preliminary results indicate that much better results from the artificial insemination will be expected this year. Only 26 calves were born from the first year's inseminations.

At Kahua Ranch Company, Ltd. a total of 121 cows were bred by artificial insemination as follows:

	No.cows bred		No.cows bred
MSC Clay's Supreme 44	14	Reno E 310	13
L4 Mischief 121	18	KCE 210E	16
L14 Mixer 110	16	Brae Arden 1124	12
NMSU 4B	16	Gillette Arden 37	16

A total of 70 calves were born as a result of the 1965 matings.

Both ranches are planning to continue with the testing of inbred lines. An inseminator will be needed to do the inseminating at Kahua Ranch next year.

A study was made to determine if empty body weight (live weight minus stomach and intestine fill) could be adequately predicted from warm carcass weight. Regression equations for predicting empty body weight from carcass weight were developed for pasture steers, feedlot steers, and Holstein steers. These equations differ markedly from those developed by Lofgreen and coworkers.

A comparison of the fatty acid compostion of the fat from a few of the 1963 test animals was made to determine if feeding regime was related to the type of fat in the Longissimus dorsi muscle. Table 1 gives a summary of the analyses with some of the production and carcass traits shown for comparison. The feedlot steers have a higher percentage of oleic and palmitoleic and a lower percentage of stearic and palmitic acids when compared with the feedlot steers. Further comparisons between treatments will be made using data from the 1964 calf crop. Rumen samples, taken from each steer, will also be analyzed and the results correlated with the fat analyses and performance traits.

Table 1. Comparison of Fatty Acid Composition of Fat from Longissimus dorsi muscle from Pasture and Feedlot Steers

Treatment	Number animals	Percent					Carcass grade [a]	Marbling score [b]	Specific gravity	Flavor score [c]	Tenderness shear [d]
		C14	C16	C16'	C18	C18'					
						Holstein					
Feed-lot	6	2.7	29.2	5.2	11.4	51.5	18.0	5.7	1.061	7.5	4.5
Pas-ture	6	2.5	32.1	3.8	18.0	43.5	13.8	3.0	1.079	7.1	5.8
						Hereford					
Feed-lot	7	3.6	33.2	4.6	13.3	45.3	19.9	5.6	1.053	7.9	4.6
Pas-ture	7	3.7	33.4	4.2	17.1	41.5	17.4	4.7	1.065	6.9	5.5

[a] 20 = average choice, 19 = low choice, 18 = high good, etc.
[b] 6 = modest, 5 = small, 4 = slight
[c] The higher values denote more acceptable flavor
[d] Warner-Bratzler shear values

Hereford and Angus heifers were exposed to Hereford, Angus, and Charolais bulls for a 75-day breeding period. Calves were dropped on pasture in January and February 1966. Weights were obtained on all calves within 24 hours after birth. The heaviest calves were sired by Charolais bulls; heifers in these breeding groups experienced the greatest difficulty in calving, and suffered the greatest death losses of calves at birth.

Thirty additional Angus heifers were added to the breeding herd in February 1966. These heifers were purchased from the same source as the original Angus females obtained during the previous year and were similar in genetic background to the foundation stock at the Experiment Station. Average weight of heifers on delivery was 690 pounds.

Bulls purchased included three Charolais from the U. S. Range Livestock Experiment Station, Miles City Montana, two Angus from Koa Ridge Farms, Oahu, and one Hereford from Daleico Ranch, Hawaii.

Six breeding groups were made up by shifting each group of females to a different breed of sire. Heifers bred to Charolais bulls in 1965 are now being bred to Angus bulls; heifers exposed to Angus bulls in 1965 are now being bred to Hereford bulls; and heifers previously bred to Hereford bulls are now in the Charolais breeding groups. The newly added Angus heifers were distributed at random to all breeding groups. Breeding groups are all single sire matings; two bulls from each breed are represented.

This study was extended in 1966 at Hawaiian Ranch Company, where approximately 150 grade Hereford cows from their commercial herd were made available for the breeding program. The Angus and Charolais bulls used at the Hawaii Agricultural Experiment Station in 1965 were transferred to Hawaiian Ranch Company for this purpose. Data will be collected to compare the performance of crossbred calves with straightbred Hereford calves.

V. Application of findings:

Preliminary indications are that calving difficulties and higher death losses may result when Hereford and Angus heifers are bred to Charolais bulls due to the large size of calf at birth. These problems were not apparent with heifers bred to Hereford and Angus bulls.

VI. Work planned for the future:

The testing of inbred lines from the Arizona project will continue at both Hawaiian Ranch Company and Kahua Ranch Company. Where sufficient numbers of calves are available, postweaning tests will be initiated on the 1965 calf crop.

The feedlot, slaughter, and carcass data from the first five years of progeny testing will be summarized and a comparison of progeny testing on pasture and in the feedlot will be made.

The crossbreeding program will be continued as shown in the project outline. One cooperating ranch has been added where bulls of the Hereford, Angus, and Charolais breeds will be bred to commercial Hereford cows, and where performance data will be collected.

VII. Publications and manuscripts:

Indrieri, Richard and Estel H. Cobb. Predicting empty body weight of beef cattle. (Manuscript.

IX. Project summary:

Hawaii Agricultural Experiment Station

Cattle Inventory - June 1966						Total
Breed	Hereford	Angus	Charo-lais	Cross-bred[a]	Hereford	
Line					Hawaiian Ranch Company	
Bulls (12 mo.or over)						
Purebred	4	3	4			11
Grade					130	130
Cows (2 yr.or over)						
Grade	59	65			407	531
Heifers (yearlings)					139	139
Calves - bulls	8	7		20	185	220
- heifers	5	4		26	161	196

Cow Production Data - 1965 Calf Crop						
Number cows bred to calve						
At 3 yr. and up	59	65			400	524
Number calves born						
Alive	16	11		46	319	392
Dead	2			5	19	26
Number calves weaned					302	302
Percent calf crop[b]						
Born	94.7	73.3		87.3	79.8	
Weaned					75.5	

Preweaning Performance - 1965 Calf Crop						
Birth weight - bulls	77	63		77		
- heifers	70	66		75		
Weaning age - bulls					221	
- heifers					225	
Weaning wt. - bulls					462	
- heifers					433	
Adjusted[c] weaning wt. - bulls					496	
- heifers					457	
Weaning score:						
Conformation[d] - bulls					10.6	
- heifers					11.1	

[a]Refers to the breeding of the calves

[b]Based on number cows exposed and total number calves born

[c]Adjusted 240-day weight = $\left(\frac{\text{weaning weight} - 70}{\text{age in days}} \times 240\right) + 70$

[d]Based on feeder grades where 17, 16, 15 = Prime; 14, 13, 12 = Choice; 11, 10, 9 = Good, etc.

Postweaning Performance - 1964 Calf Crop		
Breed	Hereford	Hereford
Line	Hawaiian Ranch Company	
Sex	Steer	Steer
Method of feeding	Pasture	Feedlot
Number on test[a]	9	12
Average age on test	806	647
Initial weight	675.7	662.5
Weaning score[b] - conformation	4.6	4.7
Days on test	311	158
Average daily gain	1.26	2.42
Final weight	1025	1031
Slaughter grade[c]	16.9	20.0

Carcass		
Fat thickness - 12th rib (in.)	0.56	0.81
Rib-eye area - sq. in.	10.9	11.2
Carcass weight (lb.)	613.7	640.9
Cutability - percent	64.4	62.3
Carcass grade[c]	17.0	20.5

[a]Three additional pasture steers are still on test

[b]Based on a scoring system where 9 is the highest score and 1 is the lowest

[c]20 = average choice; 19 = low choice; 18 = high good; 17 = average good, etc.

UNIVERSITY OF IDAHO

I. Station: Idaho Agricultural Experiment Station, Moscow

II. Project title: The improvement of economically important traits in beef cattle with special emphasis on fertility and carcass quality

III. Personnel:

Experiment Station:
R. E. Christian, Project Leader, T. D. Bell, M. L. Hemstrom, L. E. Orme, C. W. Hodgson, and S. W. Slyter

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. and V. Nature and extent of work done this year and summary of progress and conclusions to date:

Eighteen bull calves (12 Hereford, 3 Shorthorn, and 3 Angus) were individually fed for 140 days following weaning to obtain feedlot gain and feed efficiency. Most of these bulls will be leased to cooperating ranchers for progeny testing.

The steer progeny of six University bulls used in three cooperating herds in southern Idaho were fed to slaughter weight in a commercial feedlot. Table 1 gives a farm and sire-within-farm comparison of carcass characteristics.

Table 1. Carcass Composition and Quality Traits of Steer Progeny

			Average							
					U.S.D.A.					
Farm number	Sire number	Steer offspring	Live weight	Warm carcass weight	Conf. score	Marbling score	Carcass grade	Loin-eye area	Fat thickness	Dressing percent
		no.	lb.	lb.				sq.in.	mm.	%
	1	6	1018	636	9.2	6.7	7.3	10.17	20.2	62.5
1	2	4	1075	662	8.0	7.8	8.2	10.27	19.5	61.6
	Av.		1046	649	8.6	7.2	7.8	10.22	19.8	62.0
	3	7	1019	626	8.3	6.6	7.3	10.33	21.3	61.6
2	4	4	975	594	8.0	6.5	7.5	10.02	18.0	60.9
	Av.		997	610	8.2	6.6	7.4	10.18	19.6	61.2
	5	11	965	591	8.6	6.5	7.3	10.27	19.7	61.1
3	6	6	1010	615	9.2	6.8	7.8	9.68	23.8	60.9
	Av.		988	603	8.9	6.6	7.6	9.98	21.8	60.0

The two traits which showed the largest farm differences were fat thickness at the 12th rib and area of the longissimus dorsi muscle at the 12th rib. These data are being combined with the data from 1964 and 1966 for analysis to provide a more accurate estimate of the effect of farm-of-origin on differences in carcass composition and quality traits.

The analysis of live animal subjective conformation scores placed on the steers at weaning and again just prior to slaughter has been expanded to include the data from 1964 and 1965. The summary of these results is given in table 2. The proportion of the variance due to farm differences

Table 2. Variance Component Analysis of Initial and Final Subjective Conformation Score

Year and component	Depth of body	Length of body	Shoulder muscling	Length of rump	Depth of twist	Thickness of round	Width of loin	Width of body	Size and scale	Overall grade
					Initial Scores					
1963										
Farms	58.6	60.2	58.8	56.5	70.6	64.0	52.2	54.7	67.9	62.6
Sires/Farms	2.7	0.1	0.0	0.0	0.0	1.4	10.0	11.5	1.3	3.8
Individuals	38.6	39.6	41.2	43.5	29.4	34.6	37.8	33.8	30.8	33.6
1964										
Farms	2.5	17.1	0.0	8.9	0.0	0.0	9.5	7.5	0.2	0.0
Sires/Farms	9.0	0.0	7.8	0.0	10.5	0.0	0.0	0.0	6.0	7.1
Individuals	88.5	82.9	92.2	91.1	89.5	100.0	90.5	92.5	93.8	92.9
Average										
Farms	30.6	38.7	29.4	32.7	35.3	32.0	30.8	31.1	34.0	31.3
Sires/Farms	5.9	0.1	3.9	0.0	5.2	0.7	5.0	5.8	3.7	5.4
Individuals	63.6	61.2	66.7	67.3	59.5	67.3	64.2	63.1	62.3	63.2
					Final Scores					
1963										
Farms	6.8	6.4	4.7	33.6	1.3	11.8	9.3	2.7	8.7	0.8
Sires/Farms	0.4	7.1	3.0	6.6	0.0	10.3	12.7	18.6	21.5	10.6
Individuals	92.8	86.3	92.3	59.8	98.7	77.8	77.9	78.6	69.8	88.6
1964										
Farms	11.9	0.7	23.6	0.0	29.1	28.2	3.3	2.4	0.0	21.5
Sires/Farms	8.0	0.0	5.3	0.0	6.2	2.0	8.6	8.4	0.0	11.6
Individuals	80.1	99.3	71.1	100.0	64.7	69.8	88.1	89.2	100.0	66.9
Average										
Farms	9.4	3.5	14.1	16.8	15.2	20.0	6.3	2.5	4.3	11.1
Sires/Farms	4.2	3.5	4.2	3.3	3.1	6.1	10.6	13.5	10.8	11.1
Individuals	86.4	92.9	81.7	79.9	81.7	73.8	83.0	83.9	84.9	77.8

was less for all final scores than for initial scores. Farm differences accounted for an average of 32.6 percent in initial scores and 10.3 in final scores, showing a decrease of 22.3 percent. This would indicate that comparison of progeny test groups from different farms should not be attempted

until the steer calves have been subjected to a comparable environment for period of several months.

Six bulls (2 Hereford, 2 Angus, and 2 Shorthorn) have been leased to one new cooperator. He is using these bulls in his own commercial Hereford herd. He will obtain the first calves this year and will feed them to slaughter weight in his own feedlot. Although he will not be able to obtain the reciprocal crosses, this study should provide practical information on the value of breed crossing in commercial beef cattle. The results will also contribute to the study on progeny testing of beef bulls.

VI. Application of findings:

There is much interest in progeny testing of beef bulls in Idaho. Several proposals have been made to initiate a progeny testing program for the purebred cattle breeder. The progeny testing program now under way should provide answers to the problem of comparing bulls between herds. The results to date indicate that farm differences are very important at the time the steer calves are placed in the feedlot, but become much less important by the time the steers reach market weight. If the consistency of these results remains high, a practical progeny testing scheme can be developed.

VII. Work planned for the future:

The progeny testing program will be continued as outlined in the project. The data from the three years' study on the four cooperating ranches in southern Idaho will be summarized.

The study to determine the effects of tranquilizers and other central nervous depressing drugs on reproductive processes in the beef animal will be continued as experimental animals become available.

VIII. Publications and manuscripts:

None

IX. Project summary:

Idaho Agricultural Experiment Station

Cattle Inventory - June 1966				Total
Breed	Hereford	Shorthorn	Angus	
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mos. or over)	18	8	9	35
Cows (2 yrs. or over)	48	27	27	102
Heifers (yearlings)	8	4	8	20
Calves - bulls	16	9	9	34
- heifers	21	12	16	49

Cow Production Data - 1965 Calf Crop				
Number cows bred to calve:				
As 2-yr.-olds	6	4	4	14
At 3 yrs. and up	41	22	30	93
Number calves born from:				
2-yr.-olds - alive	4	3	4	11
3-yr.-olds and up - alive	38	18	27	83
- dead	2	1	0	3
Number calves weaned	42	20	31	93
Percent calf crop[a] - Born alive	89.4	80.8	91.2	87.9
- Weaned	89.4	76.9	91.2	86.9

Preweaning Performance - 1965 Calf Crop				Average
Birth weight - Bulls	69.5	63.0	64.0	66.3
- Heifers	72.3	66.1	58.5	66.2
Weaning age - Bulls	185.3	191.4	166.9	180.8
- Heifers	193.1	189.8	182.2	188.6
Weaning weight - Bulls	385.0	398.2	352.5	377.5
- Heifers	400.3	368.3	332.3	369.9
200-day adjusted weaning weight - Bulls	409.6	410.7	406.2	408.8
- Heifers	442.9	416.2	384.9	417.1
Weaning score:				
Conformation - Bulls	12.4	13.0	11.4	12.2
- Heifers	13.2	13.2	11.9	12.7

[a]Percent calves of cows bred

Postweaning Performance - 1965 Calf Crop				Total or average
Breed	Hereford	Shorthorn	Angus	
Sex	Bull	Bull	Bull	
Method of feeding		Individual		
Number on test	12	3	3	18
Average age on test	225.8	238.3	221.8	227.2
Initial weight	441.1	506.0	465.3	455.9
Initial score - conformation	12.8	14.0	13.3	13.1
Days on test	140	140	140	140
Average daily gain	1.99	1.84	1.98	1.93
Feed efficiency: TDN/100 lbs. gain	463.0	501.4	504.8	476.4
Final weight	718.5	762.0	740.7	729.1
Final score - conformation	13.1	13.8	13.0	13.2

MONTANA STATE UNIVERSITY

I. Station: Montana Agricultural Experiment Station, Bozeman, and North Montana Branch Station, Havre

II. Project title: Recurrent selection and record of performance selection in open and closed beef cattle herds. W-1, M.S. 873, AnS 104, North Montana Branch Station 71.

A. 1. The establishment of inbred lines of registered Hereford cattle, both horned and polled, that will result in improvement in such characteristics as rate and economy of gain, fertility, nursing ability, longevity, and carcass quality.

2. Maintain an outbred herd of Herefords with bulls selected and furnished by the purebred breeders. The bulls are to be primarily good, high scoring individuals according to breed association standards.

B. Establishment of an improved herd of registered Angus cattle in which the males are selected on a high level of performance as indicated by standard record of performance procedure.

C. Investigate feasibility of breeding for specific combining ability through recurrent selection.

III: Personnel:

Experiment station:
Bozeman:
R. L. Blackwell, Project Leader, F. S. Willson, A.E. Flower, and J. R. Dynes, and R. W. Miller and N. A. Jacobsen, Extension Livestock Specialist, Consultants

Havre:
Claude Windecker

U. S. Department of Agriculture, Agricultural Research Service, Miles City, Montana
O. F. Pahnish, U. S. Range Livestock Experiment Station, Consultant

Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. and V. Nature and extent of work done this year and summary of progress

Bozeman:

We continued our work at the Bozeman station much as we have in the past. This involved a two-sire ROP Hereford closed line and a few visually selected cows which were bred to an outside bull selected on type. The visual group is used only for class work. We continued with the two-sire Angus herd using one of our own top indexed bulls and a bull provided by American Breeders Service, which was from the Gartner and Denowh herd at

Sidney. Topcrossing tests using three bulls produced in the Angus herd was continued again this year. Six groups of steers produced in such a test program were fed in the feedlot with carcass evaluation tests (see project summary). The main differences appearing are that college sires seem to increase final weight, gainability, and fat thickness, but somewhat lessen rib-eye area per hundredweight and estimate of cutability. In average daily gain there was no difference with one cooperator, while there was approximately a 10 percent and 22 percent increase in steers sired by University bulls compared with those of the other two cooperators.

We indexed 16 Angus bulls, 17 Angus heifers, 18 Hereford bulls and 19 Hereford heifers.

We are continuing slaughter of 10 to 12 bulls per year and collecting carcass data.

Havre:

Two bulls of HL I were furnished one cooperator for the 1965 breeding season. Calves from these bulls will be brought to the station in the fall of 1966.

In 1965, six years of work were completed with four rancher cooperators where bulls were furnished and steers brought to the station, fed out with station steer progeny to get comparative information on progeny from rancher cows and station bulls compared to all-station cattle. In a summary analyzed by Don Anderson, graduate assistant, steers from:

Havre Control Line gained	2.41 pounds per day
Havre Crossline gained	2.32 pounds per day
Station bulls × Rancher cows	2.24 pounds per day
Rancher bulls × Rancher cows	2.13 pounds per day

Twenty-nine bulls were indexed in 1965-66. Bulls not qualifying for breeding service will be continued on feed until visual appraisal is Choice, then slaughtered and carcass evaluations made. Nineteen steers were purchased in open market for comparison with station progeny. Five additional steers from a large feedlot were selected as additional comparison steers. In 1966 the final group of cooperative rancher steers will be in the feedlot. The 1964-65 feedlot information is included in the project summary.

VI. Application of findings:

Bozeman:

The Montana Beef Performance Association shows a modest growth again this year. They have 322 active and 52 associate members. There were two private custom indexing centers in Montana that indexed 346 bulls. Ranchers indexed 696 bulls. There were 48 members who produced 6,133 certified calves this year. There was a much greater spread in price this year between bulls that had production certificates and those without.

Havre:

Considerable difficulty is being experienced with younger cows in milk production. Also, a number of new-born calves are coming with abnormalities--abnormal joints, weak tendons, parrot mouth. Older cattle, particularly Line III, develop poor feet at four to five years, and occasionally as two-year-olds. As reported earlier, various oddities and abnormalities continue to crop up at varying frequencies in the inbred lines, and sometimes in their topcrosses. This is raising the serious question in Montana studies whether continued inbreeding without some interspersed converging program is going to prove valuable as a tool for producing superior seedstock.

VII. Work plans for the future:

Bozeman:

We plan to continue cooperation with the Arizona station providing bulls from our Hereford line as required. We will continue with the Angus topcross tests until two more crops of calves have been produced and fed out. The last three bulls on this program were placed with cooperators this year. The breeding project will be revised.

Havre:

Continue with topcrossing tests. We will obtain rancher cattle through local auction ring for comparison with station cattle. Blood samples and rib-eye samples will be furnished to the Colorado station in a regional cooperative study.

VIII. Publications and manuscripts:

Anderson, Donald C. 1966. Some factors affecting performance in three closed lines of Hereford cattle. M. S. Thesis, Montana State University, Bozeman.

Windecker, Claude, Donald C. Anderson, A. E. Flower, and Robert Dynes. 1966. Review of beef cattle work at Havre for 50th Anniversary Field Day. June.

IX. Project summary:

Montana Agricultural Experiment Station

Bozeman

Cattle Inventory - June 1966				Total
Breed	Hereford	Hereford	Angus	
Line	ROP	Visual	ROP	
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mos. or over)	9	5	12	26
Cows (2 yrs. or over)	38	16	47	101
Heifers (yearlings)	13	6	17	36
Calves - Bulls	19	8	26	53
- Heifers	15	7	19	41

Cow Production Data - 1965 Calf Crop				
Number cows bred to calve:				
As 2-yr.-olds	10	1	12	23
At 3 yrs. and up	30	13	15	78
Number calves born from:				
2-yr.-olds - Alive	8	1	9	18
- Dead	1	0	0	1
3-yr.-olds and up - Alive	28	12	34	74
- Dead	0	0	0	0
Number calves weaned	32	13	41	86
Percent calf crop[a] - Born	92.5	92.8	91.5	
- Weaned	80.0	92.8	87.2	

Preweaning Performance - 1965 Calf Crop			
Birth weight - Bulls	75.5	74	71
- Heifers	72.5	60	63
Weaning age - Bulls	186.2	185.5	191.2
- Heifers	183.9	189.5	195.8
Weaning weight - Bulls	354.5	377.8	426.3
- Heifers	323.2	349.0	419.0
Adjusted weaning weight[b] - Bulls	416.4	447.0	470.0
- Heifers	365.4	379.0	419.0
Weaning score:			
Conformation - Bulls	80.2	84	80
- Heifers	78	82	81

[a]Percent calf crop - Born = calves born ÷ cows exposed
- Weaned = calves weaned ÷ cows exposed

[b]Adjusted to 205 days and age of dam

Bozeman

Postweaning Performance - 1965 Calf Crop

Breed	Hereford		Angus	Hereford		Angus
Line	ROP	Visual	ROP	ROP	Visual	ROP
Sex		Bulls			Heifers	
Method of feeding			Group			
Number on test	12	6	16[a]	14	6	19
Average age on test	218.2	217.5	223.0	217.9	221.5	229.4
Initial weight	419.9	468.3	496.8	396.9	395.8	468.9
Initial conformation score	80	89	80	79.5	82	82
Days on test	140	140	140	140	140	140
Average daily gain	2.64	2.46	2.84	1.20	1.95	1.92
Feed efficiency:						
Feed/100 lbs. gain						
Grain	537.5	537.5	617.0			
Hay	116.1	116.1	126.0			
Total	653.6	653.6	743.0			
Final weight	790.9	801.7	941.4	551.6	573.0	643.5
Final conformation score	77.75	81.70	81.00	80.0	81.0	80.0

[a]Five animals died

Carcass Data - Angus Topcross Tests with Cooperators - 1965-66 Feed Test

	Steers	Initial weight	Final weight	Average daily gain	Cold carcass weight	Dressing percent	Carcass grade b	Rib-eye area per cwt.	Fat over 12th rib	Est. of cut-ability
	no.	lbs.	lbs.	lbs.	lbs.	%		%	in.	%
Malcolm X Malcolm	8	447	831	2.02	495	59.5	20.3	2.22	0.75	50.5
College X Malcom	8	473	861	2.03	506	58.6	20.8	2.06	.78	49.9
Stanfill X Stanfill	8	437	825	2.03	480	58.2	20.4	2.34	.64	51.0
College X Stanfill	8	483	890	2.13	524	58.9	20.8	2.08	.78	50.1
Veltkamp X Veltkamp	8	479	810	1.73	473	58.5	20.7	2.17	.65	50.5
College X Veltkamp	7	473	877	2.12	490	57.6	19.9	1.96	.77	49.6

[b]P+ = 24; P° = 23; P- = 22; Ch+ = 21; Ch- = 19; G+ = 18; G° = 17; G- = 16.

North Montana Branch Station - Havre

Cattle Inventory - June 1966						Total
Breed			Hereford			
Line	HL 1	HL 2	HL 3	MC	Controls	
Purebred or grade		Purebred			Grade	
Bulls (12 mos. or over)	12	16	9	4		41
Cows (2 yrs. or over)	34	36	33	36	120	259
Heifers (yearlings)	14	8	8	4	34	78
Calves - Bulls	11	15	12	7		40
- Steers	4	1	1	1	42	49
- Heifers	14	16	10		37	77
Cow Production Data - 1965 Calf Crop						
Number cows bred to calve:	Sire 942	Sire 730	Sire 39	Sire 1124		
As 2-yr.-olds	8	8	8			24
At 3 yrs. and up	32	36	31			131
Number calved born from:						
2-yr.olds - Alive	6	7	4			17
3-yr.-olds and up - Alive	29	28	17	18		92
- Dead	1	1		2		4
Number calves weaned	31	33	17	18		99
Percent calf crop[a] - Born	87.5	79.5	53.8	56.0		
- Weaned	77.5	75.0	43.5	56.0		
Preweaning Performance - 1965 Calf Crop						
Birth weight - Bulls	79	83	79	87		
- Heifers	71	73	78	79		
Weaning age - Bulls	183	174	184	178		
- Heifers	179	172	188	181		
Weaning weight - Bulls	387	388	401	441		
- Heifers	336	340	376	385		
Adjusted weaning weight[b] - Bulls	383	398	381	445		
- Heifers	342	356	364	388		
Weaning score:						
Conformation - Bulls	3+	2	2	2+		
- Heifers	3+	2	2	2+		
Condition - Bulls	3	2-	2-	1-		
- Heifers	3	2-	2-	1-		

[a]Percent calf crop - Born - calves born ÷ cows exposed
- Weaned - calves weaned ÷ cows exposed

[b]Adjusted to 180 days

North Montana Branch Station - Havre

Cow Production Data - 1965 Calf Crop	Sire 109	Sire 270	Sire 123	Sire 136	Sire 118	Sire 158
Number cows bred to calve:						
As 2-yr.-olds	5	5	9	5	3	7
At 3 yrs. and up	15	15	14	16	15	15
Number calves born from:						
2-yr.-olds - Alive	3	4	4	5	2	6
3-yr.-olds and up - Alive	12	10	12	12	13	13
- Dead		2	0			
Number calves weaned	15	12	16	16	15	19
Percent calf crop[a] - Born	75.0	70.0	69.5	80.9	83.3	86.3
- Weaned	75.0	60.0	69.5	76.1	83.3	86.3

Preweaning Performance - 1965 Calf Crop	Sire 109	Sire 270	Sire 123	Sire 136	Sire 118	Sire 158
Birth weight - Bulls	81	90	91	90	86	81
- Heifers	77	85	81	83	76	75
Weaning age - Bulls	186	178	167	174	183	175
- Heifers	183	182	171	181	178	175
Weaning weight - Bulls	420	414	401	419	459	432
- Heifers	449	434	377	435	421	390
Adjusted weaning weight[b] - Bulls	410	420	422	419	452	442
- Heifers	449	430	392	452	425	397
Weaning score:						
Conformation - Bulls	2	2	2+	2+	1-	1-
- Heifers	2	2	2+	2±	1-	1-
Uniformity - Bulls	1-	1-	2+	2+	1-	1-
- Heifers	1-	1-	2+	2+	1-	1-

[a]Percent calf crop - Born - calves born ÷ cows exposed
- Weaned - calves weaned ÷ cows exposed

[b]Adjusted to 180 days

Montana Agricultural Experiment Station - North Montana Branch Station - Havre

Postweaning Performance - 1965 Calf Crop

Breed	Hereford										
Line	HL 1 813	HL 2 730	HL 3 739	HL 4 1135	Control 1135	HL 1 143	HL 1 146	HL 2 41	HL 2 64	HL 3 83	HL 3 103
Sex	< - - - - - - Bull			- - - - - - >	<- - - - - - - -			Steer			- - - - - - - - >
Method of feeding					Group						
Number on test	8	8	6	2	8	2	6	5	4	4	6
Average age on test	180	172	188	185	185	179	180	182	175	190	173
Initial weight	521	480	525	494	495	446	475	450	427	550	501
In. score - Cond.	79	82	83	80							
Conf.	2-	2+	2+	2	2+	2	2+	2	2	2+	2+
Days on test	168	168	168	168	259	276	264	267	287	247	257
Average daily gain	2.29	2.42	2.35	2.35	2.26	2.26	1.91	2.16	2.10	2.15	2.17
Feed efficiency: Grain/100 lb. gain	506	479	496	490	605	538	683	635	627	643	620
Feed cost/100# gain					$13.16	$12.21	$11.45	$12.99	$13.52	$11.87	$12.50
Final weight	905	887	920	888	1079	1070	982	1029	1026	1077	1055
Final score - Conf.	77.6	81	83	79.5							

Carcass Data											
Fat thickness 12th rib	9.67	10.67	8.00		13.29	19.33	13.83	19.93	15.17	15.00	12.61
Rib eye area-sq.in.	13.55	12.35	13.61		10.73	11.09	10.11	10.16	10.59	10.84	11.11
Carcass weight	645	611	641		590	600	546	586	579	611	595
Carcass grade	1	1	1		11	11	15	10	11	12	12
Tenderness	5.76	5.29	5.03		5.30	4.53	4.85	4.69	4.42	5.38	5.07
Days on feed for slaughter	273	277	280								
Marbling score					5	5	4	5+	5	5	5

Montana Agricultural Experiment Station - North Montana Branch Station - Havre

Postweaning Performance - 1965 Calf Crop

Breed	Hereford							
Line	Rancher III×HL3	Rancher III×III	Rancher V×HL2	Rancher V×V	Rancher VII×HL2	Rancher VII×VII	Rancher IX×HL1	Rancher IX×IX
Sex	Steer							
Method of feeding	Group							
Number on test	6	6	6	6	5	6	6	6
Initial weight	400	416	348	389	391	401	558	505
Days on test	285	294	303	303	280	297	251	270
Average daily gain	2.07	2.10	2.07	1.86	2.08	1.87	2.16	2.03
Feed efficiency: Grain/100 lbs. gain	605	646	609	673	591	670	658	642
Feed cost/100 lbs. gain	$13.72	$14.50	$13.78	$15.19	$13.44	$15.06	$14.76	$14.22
Final weight	988	1029	975	955	972	953	1078	1053

Carcass Data								
Fat thickness - 12th rib (mm.)	16.50	16.50	15.13	15.72	15.95	16.55	13.29	19.33
Rib-eye area - sq.in.	10.45	11.02	10.90	11.12	10.60	9.70	10.91	11.72
Carcass weight	572	572	537	551	544	542	593	588
Carcass grade	11	10	13	11	12	15	14	11
Tenderness	5.16	5.51	5.49	4.63	5.44	4.60	5.22	5.78
Marbling score	5	6	5	5	5	5	5	6

Averages of Production and Carcass Traits of Havre Line and Crossline Steer Calves and Havre Cross Rancher Controls and Rancher Control Steer Calves Slaughtered from 1961 through 1965

	Steers	Slaughter weight	Carcass weight	Dressing Percent	Average daily gain	Days on feed	Average gross return	Gross return/ day on feed	Area rib eye	Rib eye area/ 100 lbs.	Average fat thickness	Fat thickness/ 100 lbs.	Marbling score[a]	Carcass grade[b]	Estimated lean yield[c]
	no.	lbs.	lbs.	%	lbs.	no.	$	¢	sq.in.	%	in.	in.			%
Line 4	49	1015	607	59.8	2.34	251.7	221.93	0.88	11.24	1.85	0.616	0.102	6.04	19.6	50.22
Line 1 × Line 4	40	957	591	61.7	2.24	254.1	219.28	.86	10.97	1.86	.657	.111	5.15	18.8	49.76
Line 2 × Line 4	50	980	588	60.0	2.32	256.7	217.85	.84	10.88	1.85	.708	.120	5.28	19.8	48.17
Line 3 × Line 4	48	993	602	60.6	2.32	251.1	222.55	.89	11.42	1.90	.696	.116	5.43	19.4	49.92
Line 3 × Rancher III	30	982	600	61.1	2.24	266.8	227.78	.85	11.54	1.92	.662	.110	5.70	19.5	49.97
Rancher III × III	30	966	583	60.3	2.15	274.5	221.97	.81	11.23	1.93	.687	.118	5.97	19.7	49.98
Line 2 × Rancher V	30	957	574	60.0	2.25	270.6	215.74	.80	11.45	1.99	.738	.128	5.53	19.3	49.86
Rancher V × V	28	927	562	60.6	2.02	277.6	213.98	.77	11.41	2.03	.758	.135	5.43	19.5	49.65
Line 2 × Rancher VII	23	941	566	60.2	2.15	272.8	219.05	.80	11.10	1.96	.590	.104	5.48	19.4	50.38
Rancher VII × VII	23	928	558	60.1	2.09	275.7	214.56	.77	10.82	1.93	.670	.120	5.26	19.1	49.86
Line 1 × Rancher IX	6	1035	593	57.3	2.16	251.0	224.49	.89	10.91	1.84	.630	.106	4.50	18.3	49.90
Rancher IX × IX	11	984	590	60.0	2.30	257.7	222.70	.86	11.33	1.92	.643	.109	5.54	19.4	50.07
All Lines & Crosslines	187	987	597	60.4	2.31	253.4	220.43	.87	11.14	1.86	.670	.112	5.44	19.2	49.50
All Lines × Rancher Cattle	89	967	582	60.2	2.21	268.6	221.24	.82	11.35	1.95	.668	.114	5.50	19.3	50.04
All Rancher × Rancher Cattle	92	947	571	60.3	2.11	273.8	217.77	.80	11.20	1.96	.699	.122	5.58	19.4	49.86

[a]Marbling score: Trace, 3; Slight amount, 4; Small amount, 5; Modest, 6

[b]Carcass grades: Average Good, 17; High Good, 18; Low Choice, 19; Average Choice, 20; High Choice, 21.

[c]Lean Yield Estimate is calculated from a formula using carcass weight, one fat thickness measure two-thirds the length of the rib-eye, kidney fat as percent of carcass weight, and area of rib eye, and it gives an estimate of the lean boneless closely trimmed Round, Loin, Rib, and Chuck as percent of carcass weight.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

I. Station: U. S. Range Livestock Experiment Station, Miles City, Montana

II. Project titles:

AH d1-1 (Rev. 2) Breed crossing for increased production in beef cattle

AH d1-2 (Rev. 2) Development of superior lines of beef cattle

AH d1-41 A study of response to selection and genetic-environmental interaction in genetically similar groups of Hereford cattle at two locations

III. Personnel:

Experiment Station:
U. S. Range Livestock Experiment Station, Miles City, Montana
O. F. Pahnish, Project Leader, J. J. Urick, R. A. Bellows, T. M. Riley, G. S. Thompson, and R. B. Gibson

Montana Agricultural Experiment Station, Bozeman
R. L. Blackwell and A. E. Flower

U. S. Department of Agriculture, Agricultural Research Service
Fort Collins, Colorado
J. S. Brinks, Investigations Leader

Cooperators:

U. S. Department of Agriculture, Agricultural Research Service, Animal Husbandry Research Division
Beltsville, Maryland
E. J. Warwick, Chief, Beef Cattle Research Branch

Brooksville, Florida
W. C. Burns, Superintendent, West Central Florida Experiment Station

Florida Agricultural Experiment Station, Gainesville, Florida

IV. and V. Nature and extent of work done this year with summary of progress and conclusions:

Project AH d1-1 (Rev. 2) Breed crossing for increased production

Phase 1:

The fourth and final crop of calves required to complete Phase 1 of the crossbreeding study was dropped in 1965. Data on this final crop of

calves will be complete when the steers complete the feedlot test during the summer of 1966 and fall yearling weights of the heifers are obtained in October 1966. Phase 1 was designed primarily to measure the amount of hybrid vigor obtainable in two-breed crosses involving the Hereford, Angus, and Charolais breeds. Crossbreds also were obtained by mating sires of the three beef breeds to Brown Swiss cows.

Effects of breed crossing (Phase 1) on reproductive performance were summarized, although the data have not been subjected to statistical analysis. Within-breed matings (Hereford, Angus, and Charolais) were compared with breed-cross matings (all possible reciprocal matings of the three breeds named). Data collected over a period of four years are summarized in table 1. The percentage of cows calving, calf survival from birth to weaning, and net calf crop were in favor of breed crossing. A higher percentage of crossbred calves was lost at birth, however.

Table 1. Net Calf Crop as Affected by Mating System

Type of mating	Cows mated	Cows calved		Calves lost at birth		Calves lost birth to weaning		Net calf[b] crop weaned	
	no.	no.	%	no.	%	no.	%	no.	%
Within breed	286	229	80.0	4	1.7	8	3.5	217	75.9
Breed cross[a]	425	357	84.0	9	2.5	4	1.1	344	80.9

[a]All reciprocal matings

[b]Calves weaned relative to cows exposed

The incidence of calving difficulties, computed over breed-of-dam classes, was 6.8 percent for three-year-old dams and 3.9 percent for dams over three years of age. The incidence of calving difficultues was greatest in females bred to Charolais sires by about 3.2 percentage points for three-year-old dams and 1.5 percentage points for the older dams. About 75 percent of the calving difficulties encountered in cows over three years of age were in cows bred to one Charolais sire. The average actual birth weight of all calves by this sire was 97 pounds and the average birth weight of calves from the cows experiencing difficulty was 112 pounds.

Data collected on 586 calves from birth to weaning (growth traits and grades) in Phase 1 of the crossbreeding project over a period of four years have been analyzed. The least square means and estimates of hybrid vigor are summarized in table 2. Hybrid vigor in growth traits of steers ranged from 3.5 to 4.4 percent and resulted in the addition of about 20 pounds to the average weaning weight of the crossbreds. The hybrid vigor in weaning score of steers, 2.2 percent, raised the score of the crossbreds about one-seventh of a feeder grade. Crossbred heifers showed less than one-half the amount of hybrid vigor shown by the steers.

Results of crossing Hereford, Angus, and Charolais bulls on Brown Swiss cows also are summarized in table 2. Since the reciprocal crosses were not made, the data on crosses with Brown Swiss breeding were not

Table 2. Comparisons of Crossbred and Straightbred Offspring and Percent Hybrid Vigor

	Birth weight		Average daily gain birth to weaning		205-day weaning weight		Weaning score[b]	
	S[a]	H[a]	S	H	S	H	S	H
	lb.	lb.	lb.	lb.	lb.	lb.	%	%
				Beef breeds and breed crosses				
Crossbreds[c]	84.9	78.7	2.05	1.95	506	479	80.5	79.7
Straight-breds[d]	81.3	77.5	1.98	1.92	486	470	78.8	79.6
Difference[e]	+3.6	+1.2	+.07	+.03	+20	+9	+1.7	+.1
Hybrid vigor percent	+4.4	+1.5	+3.5	+1.6	+4.1	+1.9	+2.2	0
				Beef bulls × Brown Swiss cows				
Crossbreds[f]	96.8	93.6	2.26	2.23	580	550	78.2	78.2
Difference[g]	+15.5	+16.1	+.28	+.31	+94	+80	-.6	-1.4

[a]Steers = S; heifers = H
[b]Scores of 71-85 represent the choice feeder grade. Scores of 56-70 represent the good feeder grade
[c]All possible two-breed crosses of Hereford, Angus, and Charolais breeds
[d]Straight Hereford, Angus, and Charolais calves
[e]Crossbreds minus straightbreds
[f]Crossbred calves by Brown Swiss cows bred to Hereford, Angus, and Charolais bulls
[g]Brown Swiss crossbreds minus straightbreds of parent beef breeds

included in the estimates of hybrid vigor. If it is assumed that hybrid vigor from crossing was about as shown in table 2 and the advantage in birth weight carried through, it appears that higher milk production of Brown Swiss females, relative to females of the beef breeds, may have added over 50 pounds to weaning weight. The milk production level of the Brown Swiss females under range conditions did not, however, exceed the milk consumption capacity of the calves. The average weaning scores of the Brown Swiss crossbred calves were lower than those of the straightbreds but by less than one-tenth of a feeder grade.

Phase 2:

Data through weaning have been obtained on the first crop of calves produced in Phase 2 of the crossbreeding project. The evaluation of maternal qualities in crossbred females (two-breed crosses of the Hereford, Angus, and Charolais breeds) is the primary objective of this phase. The data thus far (table 3) are limited but the crossbred dams of beef breeding, at this point, show no maternal advantage. Weaning weights of the calves from crossbreds with Brown Swiss breeding do offer some suggestion that milk producing ability of the Brown Swiss is carrying through in the crossbred dams.

Table 3. Records of Progeny of Straightbred and Crossbred Dams

	Breeding of dam							
	Straightbred				Crossbred			
		Birth	Weaning			Birth	Weaning	
	Calves	weight	weight[a]	score	Calves	weight	weight[a]	score
	no.	lbs.	lbs.	%	no.	lbs.	lbs.	%
Sexes combined[b]	10	78.6	408	78.2	28	82.8	407	79.6
From BS dams[c]					3	90.0	456	79.6

[a]Adjusted to 205 days of age
[b]Adjusted to steer basis
[c]Brown Swiss = BS. Calf weights adjusted to steer basis.

Phase 3:

The first crop of calves in Phase 3 of the crossbreeding project is now on the ground, but data thus far have not been summarized. The primary objective of this phase is to determine to what extent hybrid vigor can be maintained through two-way or three-way rotational crossing of the Hereford, Angus, and Charolais breeds.

Project AH dl-2 (Rev. 2) Development of superior lines of beef cattle

Development of inbred lines:

A history of the development and summary of the performance of 14 inbred lines of Hereford cattle developed on the Station from 1934 through 1961 has been completed and published. Seven of the more productive lines or lines believed to possess experimental value are still in use. Line 11 was dropped during 1965-66 because a hereditary internal hydrocephalus was uncovered.

A test of progress made in selection of Line 1 cattle over a period of about two generations was started in the breeding season of 1965 with semen from five bulls about one-half generation apart.

Crossline study (phase 1):

Data through weaning age on four crops of calves, totaling 469 head, were collected for phase 1 of the line crossing study. The final collection of postweaning data will be made in the fall of 1966. Phase 1 was designed primarily to measure the amount of hybrid vigor obtainable in two-line crosses involving inbred Lines 1, 4, 6, 9, and 10.

Data on preweaning and weaning traits have been analyzed. Classification of least-squares means by line of sire and line of dam provided information on line characteristics. Lines 6 and 9 were below average in birth weight in both classifications, indicating that this is characteristic of the two lines. Line 1 ranked among the top in preweaning gain and weaning weight in both classifications, indicating relatively good growth potential and relatively good maternal ability. Line 6 was of interest in that it ranked lowest for preweaning gain and weaning

weight by line of sire but among the best of the lines by line of dam. This indicates that although Line 6 is relatively low in growth potential, it is relatively high in maternal ability.

Least-squares means and estimates of hybrid vigor in preweaning and weaning traits are shown in table 4.

Table 4. Comparisons of Linecross and Straightline Offspring and Percent Hybrid Vigor

	Birth weight		ADG birth to weaning		205-day weaning weight		Weaning score	
	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Males	Heifers
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	%	%
Linecross	80.1	74.7	1.83	1.73	455	428	79.4	79.4
Straightline	77.8	71.9	1.73	1.56	432	392	77.5	77.3
Difference	+2.3	+2.8	+.10	+.17	+23	+36	+1.9	+2.1
Percent hybrid vigor	+3.0	+3.8	+5.6	+10.6	+5.2	+9.3	+2.4	+2.7

In most cases, the estimates of hybrid vigor obtainable from linecrossing were higher than the estimates of hybrid vigor from crossbreeding. It seems possible that the difference between the two studies might be due to the inbreeding depression of the straightline calves in the linecrossing study. The straightbred calves in the crossbreeding study were not inbred.

Also, contrary to the results of the crossbreeding study, females showed more hybrid vigor than males in the linecrossing study. Perhaps conditions were more nearly optimum for the development of the observed traits in the crossbred steers than they were for the crossline bulls. Level of milk production, for example, could have differed considerably. It seems possible that both the inbreeding of the dams and the condition of the range utilized by the cattle in the linecrossing study could have had depressing effects on milk production. The dams in the crossbreeding study were noninbred and had the advantage of better range during a part of the preweaning period.

Crossline study (phase 2):

The primary objective of this study is to compare maternal qualities of straightline and crossline females. Too few calves were produced by straightline females in the first crop under this study to make such a comparison at this time. The dams, however, were grouped according to each original line represented (all females with Line 1 breeding, all with Line 4 breeding, etc.) to check the influence of each original line on maternal qualities of crossline dams. On the basis of weaning weights, Lines 6 and 1 appear to exceed Lines 4 and 10 in maternal qualities. This is consistent with results obtained in Phase 1.

Selection for carcass traits:

Procedures followed in the development of the carcass herd were described in earlier annual reports. Concrete results are not yet available, but it does appear that trends in growth, live animal grades, and fat thickness of slaughtered steers are in the desired direction.

Project AH d1-41 Genetic-environmental interaction study

This project is just becoming fully established and information of the type for which the project is designed is not yet available. Some comparisons of the native Miles City cattle (Line 1) with the cattle received from Brooksville, Florida for use in the project have been made at the Miles City location.

The Line 1 breeding females are generally 175-180 pounds heavier than the females shipped from Brooksville. Average calving percentages (1963 to 1965) were quite similar for the two groups of cattle. The Line 1 offspring were generally growthier than the offspring of the Brooksville cattle at all observed ages up to 18 months. Feedlot disorders (bloat and pneumonia) were more prevalent in the Line 1 cattle. Losses or disorders in heifer progeny of the two groups of cattle (1963 to 1965) were quite comparable. About 40 percent of the females originally shipped from Brooksville did require special care during the severe winter of 1964-65 because of lameness and weight loss. None of the comparable Line 1 females required such care.

VI. Application of findings:

The first phase of each of the crossing studies has indicated that hybrid vigor in preweaning and weaning traits can be obtained by crossing breeds or crossing lines within a given breed. Results from the inclusion of Brown Swiss breeding in the crossbreeding study showed that a higher level of milk production would be advantageous in beef cattle and that improvement in milk production need not result immediately in milk utilization problems. Commercial cattlemen are showing considerable interest in all of these aspects of crossing which might help them increase beef production or efficienty of production.

Improvement of carcass traits is one of the more difficult problems encountered in beef cattle breeding because of the inability to evaluate carcass traits accurately in live animals. It appears that procedures followed in the carcass study should contribute to alleviation of this problem.

Information concerning genetic-environmental interactions will aid in determining whether cattle should be bred for adaptation to limited environments to attain maximum or optimum productivity.

VII. Work planned for the future:

Publication of analyzed preweaning and weaning data from Phase 1 of the linecrossing and crossbreeding studies will receive high priority. Analysis of the postweaning data (Phase 1) will be emphasized when the

final data become available in the fall of 1966. Phase 2 of both crossing studies will be continued. Phase 3 of the crossbreeding study will be continued and a parallel phase of the linecrossing study will be initiated during the breeding season of 1966.

The carcass and genetic-environmental interaction studies will be continued as outlined in the project plans.

Matings for the test of progress made in Line 1 cattle through selection will be repeated during the 1966 breeding season. About 100 cows will be bred artificially.

In cooperation with and under the leadership of personnel at the Montana Agricultural Experiment Station, the genetics of certain protein components in milk from beef cows will be studied. This work will be done by a graduate student. Milk samples will be taken from cows in Phase 2 of the linecrossing and crossbreeding studies.

Data collected from the grade herd at this station (1939-1961) will be used in a genetic study by a graduate student at Iowa State University under the direction of personnel at that institution.

VIII. Publications, manuscripts, and presentations

Publications and manuscripts:

Bellows, R. A. 1965. Calf mortality can be cut in half at birth. Mont. Farmer-Stockman 53:43.

Bellows, R. A. 1965. Improving reproductive efficiency in beef cattle. Wash. State U. Dept. Anim. Sci. Stockmen's Handb. 16.

Bellows, R. A. 1966. Increasing pounds of calf weaned per cow bred. 17th Annual Montana Nutrition Conference, Bozeman. Proc. p. 56.

Bellows, R. A. 1966. Some effects of breed crossing on reproductive performance. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 28.

Blackwell, R. L. 1966. Expected changes in traits of economic importance through single trait selection in beef cattle. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 1.

Brinks, J. S. 1966. Hybrid vigor from crossing inbred lines of Hereford cattle. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 19.

Gibson, R. B. 1966. Effects of nutrition on puberty in beef heifers. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 38.

Pahnish, O. F. 1966. Adaptation of cattle to different environments. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 13.

Pahnish, O. F. 1966. Hybrid vigor from crossing beef cattle breeds. U. S. Range Livestock Experiment Station Beef Cattle Field Day p. 38.

Pahnish, O. F., R. A. Bellows, J. J. Urick, J. S. Brinks, and T. M. Riley. 1965. Preliminary results of crossbreeding beef cattle. U. S. Range Livestock Experiment Station. Mimeog. Rept. March.

Riley, T. J. 1966. Maternal qualities in crossbred and linecross heifers--preliminary observations. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 34.

Thompson, G. S. 1966. Rations and present feeding procedures used in measuring performance of bulls and steers. U. S. Range Livestock Experiment Station Beef Cattle Field Day. p. 5.

Urick, J. J. 1966. Improving beef carcasses--preliminary results. U. S. Range Livestock Experiment Station Beef Cattle Field Day Proc. p. 9.

Urick, J. J., J. S. Brinks, R. T. Clark, O. F. Pahnish, and F. S. Willson. 1966. History and performance of inbred lines of Hereford cattle developed at the U. S. Range Livestock Experiment Station. Mont. Agr. Expt. Sta. B. 602.

Urick, J. J., J. S. Brinks, and O. F. Pahnish. 1965. Evaluation of Hereford inbred lines and preliminary results from the crossing of Hereford inbred lines at the U. S. Range Livestock Experiment Station. U. S. Range Livestock Experiment Station. Mimeog. Rpt.

Presentations:

Gibson, R. B. 1966. Save more calves at birth. Radio broadcast over Station KATL, Miles City, Montana.

Pahnish, O. F. 1965. Adaptation of Hereford cattle exchanged between the U. S. Range Livestock Experiment Station at Miles City, Montana, and the Beef Cattle Research Station at Brooksville, Florida. American Society of Animal Science. Annual Meeting. East Lansing, Michigan.

Urick, J. J. 1965. Research under way to study hybrid vigor in Hereford cattle. Radio broadcast over Station KATL, Miles City, Montana.

Urick, J. J. 1965. Increasing efficiency in beef production through research. Montana Cattlemen's Association, Glasgow, Montana.

Urick, J. J. 1965. Improving carcass quality of our beef animals. Radio broadcast over Station KATL, Miles City, Montana.

Urick, J. J. 1966. Hybrid vigor in beef cattle. Panel discussion at IPR Indexing Center, Stanford, Montana.

IX. Project summary

U. S. Range Livestock Experiment Station

Cattle Inventory											June 1, 1966
Breed	<---				Hereford				--->	Angus	Charolais
Line	L1	L4	L6	L9	L10	L11	L12	L14	Florida		
Purebred or grade	<---					Purebred					--->
Bulls (12 mos. or over)	14	6	2	3	3	2	5	3	6	4	3
Cows (2 yrs. or over)	120	23	29	33	31	55	53	58	46	23	26
Heifers, yearlings	31	5	2	6	3	12	20	14	13	7	9
Calves - bulls	45	6	8	9	8	15	14	20	14		
- heifers	35	6	10	14	9	19	20	17	14		

Breed	4×1 1×4	6×1 1×6	9×1 1×9	10×1 1×10	6×4 4×6	9×4 4×9	10×4 4×10	9×6 6×9	10×6 6×10	10×9 9×10	Hereford
Line	<---					Crossline					--->
Purebred or grade	<---					Purebred					--->
Bulls (12 mos. or over)	2	1	2	1	2	2	3	2	2	1	
Cows (2 yrs. or over)	10	13	10	9	15	9	10	9	12	13	
Heifers, yearlings	3	6	6	5	5	4	2	5	3	2	27

U. S. Range Livestock Experiment Station

Cattle Inventory											June 1, 1966
Breed	Hereford		Angus	A×H H×A	C×H H×C	H×BS	A×C C×A	C×BS	A×BS	Crossbred	
Line	<---Purchased --->			<------------- Crossbred ------------->						Phase 2 1/	2/
Purebred or grade	<----------------------------- Grade ------------------------------>										
Bulls (12 mos. or over	13			1	3	1	1	3	1		
Cows (2 yrs. or over)	157			37	30	6	44	9	6		
Heifers, yearlings	74	79	125	16	16	4	8	4	3		
Calves - bulls	47									22	19
H - heifers	50									21	23

1/ Dams - C×A, C×H, A×BS, C, H×C, A×C, H×BS. Sire - H×A.
2/ Dams - A, A×C, A×H, C×A, H×BS, H×A, C×BS. Sire - C×H.

Breed	<------Crossbred------->				<---------------Hereford--------------->						
Line	<------ Phase 3 --------> 3/	4/	5/	6/	A.I	<---------Linecross Phase 2 --------> 7/	8/	9/	10/	11/	12/
Purebred or grade	<-------- Grade -------->				<---------------Purebred--------------->						
Cows (2 yrs. or over)					49						
Calves - bulls	18	8	5	12	23	9	8	12	13	5	6
- heifers	11	10	15	7	19	8	5	8	5	7	10

3/ Dams - C×H, H×A, H×C, H, A×H, A×BS, C×BS. Sire - A×C.
4/ Dams - A×A, A×H, C×H, C×A, H×BS, H×A, H×C, C×BS. Sire - Angus.
5/ Dams - H×A, A×C, A×H, C×C, H×C, H×A, H×BS, C×A, C×H, A×BS. Sire - Charolais
6/ Dams - H×A, A×BS, A×C, H×C, H×H, C×A, C×H, A×H, Sire - Hereford
7/ Dams - 6×10, 1×1, 4×1, 10×9, 10×1, 10×6, 4×9, 9×10, 6×4, 6×10, 1×4, 9×9, 6×6, 1×10, 9×4. Sire - 4×10.
8/ Dams - 1×1, 9×1, 6×4, 9×6, 4×1, 4×10, 10×4, 6×6, 6×9, 1×4, 10×10, 1×9, 4×6. Sire - 4×9.
9/ Dams - 1×4, 6×1, 9×6, 1×6, 6×9, 4×4, 10×1, 4×1, 10×9, 6×1, 10×10, 9×10, 4×9, 9×4, 6×6. Sire - 1x9.
10/ Dams - 4×6, 6×1, 6×10, 4×4, 1×9, 1×6, 1×1, 10×10, 9×10, 6×4, 10×6, 9×1, 10×9. Sire - 6×9.
11/ Dams - 1×6, 10×10, 9×6, 4×9, 1×4, 1×1, 6×10, 9×9, 10×4, 9×4. Sire - 6×4.
12/ Dams - 6×9, 6×4, 9×9, 9×10, 4×10, 6×1, 4×6, 4×4, 1×1, 1×6, 1×10. Sire - 10×6.

Cow Production Data - 1965 Calf Crop						
Line	L1	L9	L11	L12	L14	Carcass
Breeding	<----------------		Hereford		--------------->	
Number cows bred to calve At 3 yrs. and up	15[1/]	6	64[2/]	54[3/]	57[4/]	59[5/]
Number calves born - alive	5	5	31	38	37	40
- dead	0	1	5	2	1	2
Number calves weaned	5	4	31	37	32	38
Percent calf crop - born	71.4	100.0	66.7	80.0	82.6	77.8
- weaned	71.4	66.7	57.4	74.0	69.6	70.4

Preweaning Performance - 1965 Calf Crop						
Birth weight - bulls	63	62	78	88	72	81
- steers			85	102	83	82
- heifers	72	69	71	78	73	74
Weaning age - bulls	169	175	185	183	180	185
- steers			151	138	120	144
- heifers	175	183	184	185	185	193
Weaning weight - bulls	357	330	407	429	383	424
- steers			370	283	306	334
- heifers	333	346	365	386	380	419
Adjusted weaning weight - bulls	376	338	399	422	383	415
- steers			424	339	418	396
- heifers	340	342	360	376	372	396
Weaning score: Conformation - bulls	76	79	81	80	78	82
- steers			84			
- heifers	75	77	78	79	78	81

1/ Seven cows sold 11-10-64, 1 cow died 1-8-65. Computed on basis of 7 remaining cows.

2/ One cow sold 9-7-64, 7 cows sold 11-10-64, 2 sold 1-5-65. Computed on basis of 54 remaining cows.

3/ Three cows sold 11-10-64, 1 sold 1-5-65. Computed on basis of 50 remaining cows.

4/ One cow sold 9-7-64, 8 sold 11-10-64, 2 sold 1-5-65. Computed on basis of 46 remaining cows.

5/ Four cows sold 11-10-64, 1 sold 1-19-65. Computed on basis of 54 remaining cows.

Cow Production Data - 1965 Calf Crop						
Project	Linecrossing Phase 1		Phase 2		GEI Study	
	<---------------------	-----Hereford	-------------	---------	------------	------>
Breeding	Straight-line	Cross-line	Straight-line	Cross-line	Florida	L1
Number cows bred to calve At 3 yrs. and up	39 1/	122 2/	6	37	37 3/	75 4/
Number of calves born - alive	29	96	2	15	28	62
- dead	0	1	0	0	0	3
Number calves weaned	27	90	1	14	25	56
Percent calf crop - born	90.6	86.6	33.3	40.5	87.5	92.9
- weaned	84.4	80.4	16.7	37.8	78.1	80.0

Preweaning Performance - 1965 Calf Crop						
Birth weight - bulls	74	79	95	80	76	78
- steers		80				
- heifers	72	73		62	71	75
Weaning age - bulls	183	183	190	182	185	189
- steers		140				
- heifers	186	188		174	183	185
Weaning weight - bulls	376	397	386	398	372	391
- steers		350				
- heifers	356	393		324	341	374
Adjusted weaning weight - bulls	372	390	371	393	363	376
- steers		427				
- heifers	346	380		333	336	367
Weaning score: Conformation - bulls	77	80	77	80	77	77
- heifers	78	79		73	75	76

1/ Six cows sold 11-10-64, 1 missing--presumed dead. Computed on basis of 32 remaining cows.
2/ Ten cows sold 11-10-64. Computed on basis of 112 remaining cows.
3/ Five cows sold 11-10-64. Computed on basis of 32 remaining cows.
4/ Three cows sold 11-10-64, 1 sold 1-5-65, 1 died 12-65. Computed on basis of 70 remaining cows.

Cow Production Data - 1965 Calf Crop						
Project	<------------- Crossbreeding					------------->
	<-- Phase 1	------- >		< ---Phase 2	------ >	
Breeding	A, H, C Straight-bred	AHC Cross Cross-bred	ABS, CBS,HBS	Straight-bred dams1/	Cross-bred dams2/	Cross-bred dams3/
Number cows bred to calve At 3 yrs. and up	684/	1105/	346/	247/	48	9
Number calves born - alive	54	91	24	12	30	4
- dead	0	0	0	1	2	0
Number calves weaned	53	86	22	10	29	4
Percent calf crop - born	85.7	91.9	100.0	56.5	66.7	44.4
- weaned	84.1	86.9	91.7	43.5	60.4	44.4

Preweaning Performance - 1965 Calf Crop						
Birth weight - bulls	74	88	98			
- steers	80	85	89	77	84	89
- heifers	80	80	92	75	74	92
Weaning age - bulls	185	186	195			
- steers	190	190	180	187	184	185
- heifers	187	189	189	191	190	190
Weaning weight - bulls	441	470	564			
- steers	440	464	432	413	409	452
- heifers	420	425	470	414	405	433
Adjusted weaning weight - bulls	428	457	529			
- steers	422	444	432	395	402	444
- heifers	408	409	452	394	389	415
Weaning score Conformation - bulls	81	81	80			
- steers	81	82	76	78	80	81
- heifers	80	81	78	78	79	76

1/ Straightbred H, A, and C dams
2/ Dams were two-breed crosses of H, A, and C breeds
3/ Two-breed crosses. H,A, or C x BS
4/ Five cows sold 11-10-64. Computed on basis of 63 remaining cows.
5/ Ten cows sold 11-10-64, 1 died 2-17-65. Computed on basis of 99 remaining cows
6/ Ten cows sold 11-10-64. Computed on basis of 24 remaining cows.
7/ One cow sold 9-7-64. Computed on basis of 23 remaining cows.

Postweaning Performance - 1965 Calf Crop

	<------------ Hereford					------------>
Breeding	Straight-line	Linecross		Grade		
Project	<--Linecrossing--> Phase 1	Phase 1	Linecrossing Phase 2	Carcass	Purebred 1/	Purebred Line 1	Florida GEI
Sex	<--- Bull					--->
Method of feeding	<--- Group - Feedlot					--->
Number on test	12	47	9	15	40	31	12
Average age on test	198	183	183	201	198	205	200
Initial weight	367	408	413	440	416	405	381
Initial score: Conformation	78	80	80	82	80	77	77
Days on test	196	196	196	196	196	196	196
Average daily gain	2.9	3.0	2.7	2.9	2.9	2.8	2.8
Final weight	925	973	945	1006	987	961	921
Final score: Conformation	77	79	78	80	77	76	76

1/Three L1 bulls, 1 L9 bull, 12 L11 bulls, 10 L12 bulls and 14 L14 bulls

Postweaning Performance - 1965 Calf Crop

Breeding	A,H,C Straight-breds	AHC-Cross Cross-breds	ABS-CBS HBS	Straight-bred dams1/	Cross-bred dams2/	Cross-bred dams3/
Project	<--- Crossbreeding					--->
	<--- Phase 1		--->	<--- Phase 2		--->
Sex	<--- Steer					--->
Method of feeding	<--- Individual		--->	<--- Group		--->
Number on test	19	33	6	3	14	3
Average age on test	207	206	193	196	198	200
Initial weight	462	473	454	408	425	467
Initial score: Conformation	81	82	77	77	80	81
Days on test	193	193	196	196	196	196
Average daily gain	2.4	2.4	2.6	2.7	2.5	2.7
Final weight	924 4/	934 4/	964 4/	934	909	989

1/ Straightbred H, A, and C dams
2/ Dams were two-breed crosses of H, A, and C breeds
3/ Two-breed crosses. H, A, or C × BS.
4/ Test not completed

UNIVERSITY OF NEVADA

I. Station: Nevada Agricultural Experiment Station, Reno

II. Project titles: Interaction between genotype and environment in selection for economically important traits in Hereford cattle (304 W-1).

The effect of genetic-environmental interactions on selection responses (390).

III. Personnel:

Experiment Station:
C. M. Bailey, Project Leader, S. P. Hammack, J. E. Hunter, C. R. Torell

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year and summary of progress:

The five lines which were formed in 1955 were continued as two-sire lines. A total of 132 calves were tested in individual pens during 1965-66. Data on growth rate, feed conversion, and conformation scores are reported in the project summary.

An analysis of performance data collected during the period 1955 to 1966 is in progress. The main purpose of the analysis is to determine selection intensities and time trends for traits in lines developed under different environmental conditions.

As in the previous year, a portion of the bulls from each of the five lines was slaughtered at the conclusion of the 140-day postweaning test. The remaining bulls are being fed out at the Main Station Field Laboratory and will be slaughtered upon reaching a weight of 1000 pounds. These data will provide information on body composition, feed intake, and the efficiency of energy conversion of progeny produced in lines at the Main Station Field Laboratory, Reno, Nevada and at the Knoll Creek Field Laboratory near Contact, Nevada.

Sires from the efficiency lines (Lines 2 and 5) at the two locations were sent to San Carlos, Arizona for use in the regional progeny testing program.

A study on certain aspects of bull beef production was completed. Under the conditions of this study, bulls and steers were similar in preweaning growth rate. Bulls grew more rapidly in the feedlot than steers, were more efficient in feed conversion, and produced leaner carcasses. Carcasses of steers were superior in marbling and in carcass grade. Although sex differences in measures of tenderness frequently were not significant at the .05 probability level, _l. dorsi_ from steer carcasses was

slightly more tender than muscle from bulls. Stilbestrol implantation (24 mg.) caused a significant increase in the growth rate of steers and a reduction in the amount of fat in the carcass. Bulls implanted with 60 mg. of stilbestrol tended to gain more rapidly and were somewhat fatter than controls, but the effect of the hormone on characteristics of bulls was less pronounced than with steers. There was some indication of an increase in the carcass grade of older bulls which had received stilbestrol. Differences in daily gain, feed efficiency, and in tenderness and flavor of the _l. dorsi_ of bulls and stilbestrol-implanted steers were not significant.

The purpose of the small animal study (Project 390) is to evaluate response to selection under two nutritional regimens. Three lines are maintained on a standard diet; an additional three lines receive _ad libitum_ a mixture consisting of 55 percent standard diet: 45 percent cellulose during a 6-week postweaning test (28 to 70 days of age). Progeny in two of the lines on each diet are selected on the basis of growth rate during the test period. The other lines serve as controls. Thus far, five generations of rats (N=1993) have been raised under the two nutritional regimens. Means for test gain (28 to 70 days of age) for the first five generations are summarized in table 1. A detailed analysis of data will not be conducted until progeny of Generation 5 have been tested. However, it is clear that selection for rapid growth has been effective on both diets.

Table 1. Mean Test Gain (28 to 70 Days) According to Generation, Sex, Diet

Generation	Sex	Regular Diet[a]			Restricted Diet[b]		
		Rep.A	Rep.B	Control	Rep.A	Rep.B	Control
Base	♂	172.3	178.3	174.5	132.5	125.7	129.6
	♀	97.9	96.6	101.0	79.2	80.4	78.4
1	♂	177.5	172.8	183.5	144.3	128.8	133.0
	♀	97.8	101.3	101.6	83.8	77.0	75.7
2	♂	183.2	171.7	171.1	136.3	129.2	131.9
	♀	107.9	97.0	96.1	82.4	82.5	79.7
3	♂	207.1	197.1	183.3	148.9	134.6	139.6
	♀	112.0	104.4	97.9	91.1	82.2	80.9
4	♂	194.3	188.8	157.4	139.9	133.5	124.1
	♀	112.0	109.1	93.1	86.9	90.4	77.7

[a]Purina Laboratory Chow
[b]55% Purina Laboratory Chow: 45% cellulose.

V. Application of findings:

The production of beef from bulls fed high-concentrate rations and slaughtered at 13 to 14 months of age appears to have strong potential. It is doubtful that beef from carcasses of older bulls which have

been raised under less intensive conditions will be of sufficient quality to gain widespread acceptance by consumers.

VI. Work planned for the future:

The five lines at the two locations will be continued.

The study of performance data will be completed.

Data on body composition and energy conversion will be evaluated.

Participation in the regional progeny testing program will continue.

Future plans for the small animal work are indefinite. If funds are available, sires from the select lines will be progeny tested. Food intake and body composition of random samples of progeny will be measured at various stages of development.

VII. Publications and manuscripts:

Bailey, C. M. 1965. Better beef through breeding research. Nev. Ranch and Home Rev. 3(2):11.

Bailey, C. M., C. L. Probert, and V. R. Bohman. 1966. Growth rate, feed utilization, and body composition of young bulls and steers. J. Animal Sci. 25(1):132-137.

Bailey, C. M., C. L. Probert, Paula Richardson, V. R. Bohman, and Julianne Chancerelle. 1966. Quality factors of the longissimus dorsi of young bulls and steers. J. Animal Sci. 25(2): 504-508.

VIII. Project summary:

Nevada Agricultural Experiment Station

Cattle Inventory - June 1966						Total
Breed	<------------------		Hereford		------------------>	
Line[a]	1	2	3	4	5	
Purebred or grade			Purebred			
Bulls (12 mos. or over)	6	6	4	6	6	28
Cows (2 yrs. or over)	36	36	35	34	36	177
Heifers (yearling)	6	6	6	6	6	30
Calves - bulls	17	12	16	13	12	70
- heifers	14	14	8	12	14	62

Cow Production Data - 1965 Calf Crop						Total or Avg.
Number cows bred to calve At 3 yrs. and up	32	32	32	32	32	160
Number calves born-alive	27	27	28	25	28	135
- dead	1	1	0	3	1	6
Number calves weaned	27	26	28	24	28	133
Percent calf crop[b]-born	84.4	84.4	87.5	78.1	87.5	84.4
-weaned	84.4	81.2	87.5	75.0	87.5	83.1

Preweaning Performance - 1965 Calf Crop						Average
Weaning age - bulls	223	228	228	230	223	226
- heifers	225	220	224	228	214	222
Weaning weight - bulls	447	455	473	388	385	430
- heifers	414	403	409	330	331	377
Average inbreeding - bulls	12	7	5	8	5	7
- heifers	12	8	8	7	5	8

[a]Lines 1, 2, and 3 - irrigated pastures. Lines 4 and 5 - range conditions.

[b]$\frac{\text{Calves born alive/weaned}}{\text{Cows exposed to bull}} \times 100$

Tot

Postweaning Performance - 1965 Calf Crop						Total or Avg.
Breed	<--------------------		Hereford			------------------->
Line[a]	1	2	3	4	5	
Sex			Bull			
Method of feeding			Individual feedlot			
Number on test	16	14	16	13	16	75
Average age on test	244	249	249	251	244	247
Initial weight	457	460	484	399	392	438
Initial score: Conformation[b]	84.1	84.0	85.3	84.0	83.4	84.2
Days on test	140	140	140	140	140	140
Average daily gain	1.764	1.679	1.736	1.014	0.971	1.433
Feed efficiency: Lb. gain/100 lb. TDN	20.3	19.7	19.9	14.2	13.7	17.6
Final weight	704	695	727	541	528	639
Final score: Conformation[b]	85.2	84.6	85.6	84.4	84.3	84.9
Average inbreeding - %	12	7	5	8	5	7

Postweaning Performance - 1965 Calf Crop						Total or Avg.
Breed	<--------------------		Hereford			------------------->
Line[a]	1	2	3	4	5	
Sex			Heifer			
Method of feeding			Individual feedlot			
Number on test	11	12	11	11	12	57
Average age on test	246	241	245	249	235	243
Initial weight	420	410	412	335	334	382
Initial score: Conformation[b]	84.3	84.7	84.9	83.6	83.8	84.3
Days on test	140	140	140	140	140	140
Average daily gain	1.250	1.279	1.164	0.779	0.786	1.052
Feed efficiency: Lb/ gain/100 lb. TDN	16.2	16.7	15.5	13.1	13.5	15.0
Final weight	595	589	575	444	444	529
Final score: Conformation[b]	84.6	85.0	85.1	84.5	84.4	84.7
Average inbreeding - %	12	8	8	7	5	8

[a]Lines 1, 2, and 3 received 2 parts grass hay: 1 part concentrate <u>ad lib</u>. Lines 4 and 5 received 3 lb. alfalfa pellets plus grass hay <u>ad lib</u>.

[b]Scores from 100 (outstanding) to 67 (cull)

NEW MEXICO STATE UNIVERSITY

I. Station: New Mexico Agricultural Experiment Station, Las Cruces

II. Project title: Inheritance of heart defects and evaluation of factors affecting production and anomalous traits in beef cattle

III. Personnel:

Experiment Station:
L. A. Holland, Project Leader, A. L. Neumann, and E. E. Ray

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year

All eleven calves from the matings of a bull which had sired a calf with a patent ductus arteriosus with his daughters were born alive and, at their present young ages, apparently are growing normally. Inbreeding coefficients of these calves range from 0.42 to 0.47.

One 3-year-old cow, diagnosed by stethoscope at weaning to have a patent ductus arteriosus, failed to get in calf and was slaughtered. The ductus arteriosus was closed, and no septal defects were observed.

The eleven calves from the mating of a bull which had sired a calf with the ventricular septal defect with daughters of bulls siring the defect were born alive and, at their present young ages, apparently are growing normally. A few more calves from these matings are expected in 1966.

Production data collected are summarized in the project summary. Carcass data on 29 steers are also summarized in the project summary.

Compilation of data for the regional bulletin was begun but not completed.

VII. Work planned for the future:

Most of the male calves born in the fall of 1965 and spring of 1966 were castrated. These will be slaughtered in 1967 and their hearts will be examined. Calves from repeat matings in the heart groups will be born in the fall of 1966 and spring of 1967.

VIII. Publications and manuscripts:

None

IX. Project summary:

New Mexico Agricultural Experiment Station

Cattle Inventory - June 1966			Total
Breed	Hereford	Hereford	
Line	Old	Outcross	
Purebred or grade	Purebred	Purebred	
Bulls (12 mos. or over)	6	1	7
Cows (2 yrs. or over)	38	18	56
Heifers (yearlings)	9	3	12
Calves - Bulls	2	1	3
- Steers	16	2	18
- Heifers	10	1	11

Cow Production Data - Calf Crop July 2, 1964 to June 30, 1965			
Number cows bred to calve:			
As 2-year-olds	3	3	6
At 3 yrs. and up	31	12	43
Number calves born from:			
2-yr.-olds - alive	3	3	6
3-yr.-olds and up - alive	20	8	28
- dead	3	0	3
Number calves weaned	22	10	32
Percent calf crop[a] - born	76	73	74
- weaned	65	67	66

Preweaning Performance		
Birth weight - bulls	77	69
- heifers	72	70
Weaning age - males[b]	240	240
- heifers	240	240
Weaning weight - males[b]	547	447
- heifers	454	412
Weaning score:		
Conformation - males[b]	6.8	5.4
- heifers	6.6	6.4
Condition - males[b]	11.2	11.0
- heifers	10.6	11.2
Average inbreeding - males[b]	.30	.22
- heifers	.31	.27

[a]Number calves born/weaned ÷ number cows exposed × 100

[b]Old Line, all bulls. Outcross Line, all steers.

Postweaning Performance[a]			
Breed	Hereford	Hereford	Hereford
Line	Old	Outcross	Grade
Sex	Bull	Bull	Steer
Method of feeding	Individual	Individual	Group
Number on test	13	1	29
Average age on test	313	323	
Initial weight	628	669	367
Days on test	140	140	238
Average daily gain	2.72	2.63	2.20
Feed efficiency: TDN/100 lb. gain	476	449	508
Final weight	1010	1037	892
Average inbreeding	0.29	0.27	

[a]Bulls completing test calendar year 1965. Steers slaughtered 1965.

Carcass Data	
Fat thickness - 12th rib	0.39
Rib-eye area - sq. in.	9.89
Carcass weight	528
Carcass grade	Choice-
Cutability yield grade	3.1

OREGON STATE UNIVERSITY

I. Station: Oregon Agricultural Experiment Station, Corvallis

II. Project title: Diallel crossing in beef cattle and its use in breed improvement

III: Personnel:

Experiment Station:
Ralph Bogart, Project Leader, Walter Kennick, A. T. Ralston, L. D. Calvin, A. F. Anglemier, Paul Humes, Prentiss Schilling, Joe Templeton, W. A. Sawyer, Joe Wallace, James McArthur, and Bob Raleigh

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year:

1. The fourth and last diallel matings of Hereford Lines 1, 2, and 3 were made. Data were gathered on suckling gains, feed test, rate and efficiency of gains, and scores for conformation and condition on all of the 1964 crop of linecross and inbred calves. In addition, carcass data were obtained on the bulls at 1000 pounds weight and blood levels of creatinine, amino acid nitrogen, and urea nitrogen for all calves born in 1964 at 500 and 750 pounds body weight and on all bulls at 1000 pounds body weight. The same data have been obtained on all of the 1965 calves with the exception of three bulls and one heifer which have not finished the tests.

2. The first group of inbred and linecross heifers produced by the diallel matings were all bred to the same Angus bull and produced four bull and nine heifer calves from the 13 two-year-old cows.

3. The linecross and inbred heifers produced by the first and second diallel matings have all produced calves in 1966.

4. The Angus line has been continued. One bull in this line has made an exceptional record. He weighed 1000 pounds at 334 days of age. This gives him a weight per day of age of 3.01 pounds.

5. The bulls from the 1964 calf crop and most of those born in 1965 were slaughtered at 1000 pounds. At the time of slaughter, weights of testes, adrenals, thyroid glands, and pituitary glands were obtained. Also, live-dead stains were made on sperm from the head and tail of the epididymis of both testes on each bull to determine if there is an increase of fertility of the linecross bulls over the inbred bulls. Carcass data were obtained from each of these bulls which included yield of

trimmed wholesale cuts, percent of lean, fat, and bone made from one rib section of the rib cut. Also, the meat was evaluated by a taste panel.

6. In cooperation with Kansas State University and John H. Landers, Extension Livestock Specialist, a study was conducted on 494 beef calves from four inbred lines to determine the influence of age of dam, sex, time of birth, daily feed intake, rate of gain, and age in days at 227 kg. on feed efficiency, and feed efficiency above maintenance in a 136 kg. feed test period.

7. In cooperation with Extension Agents and Extension Livestock Specialists Dean Frischknecht and John H. Landers, about 2000 cows in various herds over the state are being used in studies on synchronization of estrus. These cows are all being artificially inseminated. Some of the bulls used are those in the genetic-environmental interaction studies.

8. In 1964, cows that were problem breeders were fed Repromix for 18 days prior to the breeding season.

V. Summary of progress and conclusions to date:

1. The data from studies of epididymal sperm of the bulls slaughtered at 1000 pounds weight have been analyzed and the material summarized.

   Generally speaking, no difference was found between inbred and linecross bulls for spermatozoan morphology. The six inbred and 21 linecross bulls were very similar in all categories studied. The inbred Angus bulls showed some differences but these differences cannot be given strong consideration since there were only two Angus bulls in the study.

   An analysis of variance indicated that there was a statistically significant difference between breeding types for live spermatozoa, tail beads, and bent tails. No significant difference was found for normals, neck beads, tailless heads, or coiled tails. Since a particular breeding type that was superior in one characteristic was inferior in another, there was no generally superior breeding type.

   There was a significant difference due to location--head or tail of the epididymis--for live spermatozoa, neck beads, tailless heads, coiled tails, and bent tails. This was believed to be a result of the maturation process of the spermatozoa from the head to the tail of the epididymis.

   No one line of inbreds seemed to excel any other line when comparing over-all merit or morphology characteristics studied for general combining ability. To estimate specific combining ability, means of 1 $\times$ 2, 1 $\times$ 3, and 2 $\times$ 3 were also compared.

No significant differences were found here for over-all merit.

There were many differences between individual bulls in specific categories studied. There were more differences between bulls than between breeding types.

In all cases when comparing any two groups of bulls, where there was a higher number of live spermatozoa there was also a lower number of normals. This was due to the fact that the spermatozoa showing protoplasmic droplets were almost always alive.

A higher number of protoplasmic droplets on the neck of the sperm was found in sperm from the head of the epididymis, and a higher number of midpiece droplets in sperm from the tail of the epididymis. This is believed to be a result of maturation of the spermatozoon as it passes from the head to the tail of the epididymis. As the spermatozoon matures, the droplet migrates to the tail and is eventually lost.

It appears that morphology and percentage of live sperm may be as good in the semen of inbred as in the semen of linecross bulls when evaluated at comparable weights if selection has been practiced for improved fertility during the time inbreeding is being done.

2. Rate of gain and feed efficiency of calves born in 1964 and 1965 show no advantages of linecross bulls over inbred bulls and no difference between Hereford and Angus bulls. On the other hand, the linecross heifers were markedly superior to the inbred Hereford or Angus heifers in rate of gain and were also much more efficient in feed use than the inbred Herefords. Feed records were not obtained on the Angus heifers. For example, the inbreds gained 1.93 pounds per day for the Hereford and 1.86 pounds per day for the Angus inbred heifers, whereas the linecross heifers gained 2.38, 2.16, and 2.40 for the 1 × 2, 1 × 3, and 2 × 3 linecrosses, respectively. These results support the hypothesis of Dr. H. H. Stonaker of Colorado of homogametic heterosis.

3. The suckling gains of the 1965 calf crop were low for the Hereford and Hereford × Angus calves since they were on nonirrigated pastures and grazing conditions were poor due to loss of subclover from freezing and poor grass growth due to exceedingly dry conditions. The linecross and crossbred bulls gained somewhat more rapidly than inbred bulls, but there were no differences in gains of heifers. The Angus bulls and heifers gained rapidly since they were on irrigated pastures.

4. The carcass data from the 1964 bulls that were slaughtered at 1000 pounds weight show that the carcasses from the linecross Hereford bulls graded higher and contained a higher percentage of fat than the inbreds but not as high as carcasses from the Angus bulls.

5. The results of the analyses in cooperation with Kansas State and John Landers support the following conclusions:

   a. Males were more efficient in converting a high roughage ration into body weight than heifers. Bulls at a given weight consumed no more feed than heifers, yet the bulls gained 0.204 kg. more daily than heifers. Males were 23 percent more efficient than heifers during the 136 kg. test.

   b. Line differences existed in efficiency, rate of gain, and daily feed intake. Line 2 animals gained at the highest rate, were most efficient, and consumed the least amount of feed daily. The Angus males and females made the least daily gain of any line of cattle. Line 3 consumed the greatest amount of feed daily and was the least efficient.

   c. The calves studied were more efficient during the early part of the feed test period. Males were 70 percent and females were 73 percent as efficient in the 341 kg. subperiod as during the 238 kg. subperiod. The daily rate of gain declined very slightly, whereas feed consumption increased as the cattle became heavier. Gross feed efficiency for males declined from 0.081 kg. gain per kilogram total digestible nutrients consumed in the 238 kg. subperiod to 0.058 kg. gain per kilogram total digestible nutrients consumed in the 341 kg. subperiod. Gross efficiency for heifers declined from 0.063 kg. gain to 0.046 kg. gain per kilogram total digestible nutrients consumed in the same subperiods.

   d. Daily rate of gain and feed efficiency were highly correlated. This would lead one to conclude that rate of gain would be a very effective tool in selecting cattle for efficiency within lines. This would not require individual feeding of animals. However, the results indicate that mistakes could be made by using rate of gain to obtain increased feed efficiency if comparisons were made between lines of breeding.

   e. Assuming that weight$^{.73}$ is a correct criterion for determining maintenance requirements, feed efficiency above maintenance declines in a very regular manner as body weight increases from 227 to 363 kg. The males gained at the rate of 0.153 kg. per kilogram of total digestible nutrients consumed in the 238 kg. subperiod, and declined 0.105 kg. gain per kilogram total digestible nutrients consumed in the 341 kg. subperiod. The females gained at the rate of 0.108 kg. per kilogram total digestible nutrients consumed in the 341 kg. subperiod.

   f. There was some yearly variation in feed efficiency which appears to have been a reflection of yearly variation in rate of gain. The age of dam at the time of birth of the

calf had no significant effect on feed efficiency. Time of birth within the calving season had no significant effect on rate of gain or feed efficiency.

6. Data on organ weights reveal no differences between inbreds and linecrosses for thyroid, pituitary, adrenal, and heart weights, but testes from linecross bulls were heavier than testes from inbred Hereford bulls. The testes weight of the Angus bulls was higher than for any of the Hereford groups.

7. Of the seventeen 1964 cows that were problem breeders and were fed Repromix prior to the breeding season for 18 days, 11,or 65 percent, calved in the spring of 1965.

8. Cows that were not pregnant were slaughtered and a study of the reproductive tracts made in an attempt to find out why they were open. Three of the 13 cows showed infection in the uterus. Five appeared to be normal, and five showed endocrine disturbance.

9. The calves from the fourth mating in the diallel crosses have all come and are doing well on pasture. Pastures have been good but dry weather is causing them to dry up now.

VI. Application of findings:

The results from the diallel crosses are not complete. Consequently, it is not possible at this point to determine the applications that may be made from the findings. By September 1, 1967, all data on the inbreds and linecrosses dealing with growth, feed efficiency, blood, liver enzyme, endocrine, and carcass studies should be complete. At this time a summarization of the material can be made. All the data on the calf producing ability of inbred and linecross heifers will not be obtained until 1969.

VII. Work planned for the future:

1. Make some initial matings to provide the base for two new Hereford lines using our linecross heifers and bulls from our own linecrosses of the U. S. Range Livestock Experiment Station, Miles City, Montana. Only heifers that have had two calves by the Angus bull will be mated this year.

2. Continue the Angus line as a two-sire line.

3. Mate two- and three-year-old linecross and inbred Hereford heifers to the same Angus bull to obtain information on their calf producing abilities.

4. Feed test all calves born in 1965 with the heifers tested from 400 to 750 pounds and the bulls from 450 to 800 pounds body weight. The bulls not essential for breeding will be carried to a weight of 1000 pounds and slaughtered. Carcass data will

be obtained including yield of trimmed wholesale cuts, percent lean, bone, and fat of a selected cut, and evaluation by a taste panel. In addition, weights of testes, thyroid glands, adrenal glands, and pituitary glands will be obtained.

5. Data have been gathered on the calf producing abilities of heifers sired by bulls fromthe four inbred lines of Herefords. These data will be analyzed and,in cooperation with Dr. McArthur, manuscripts for publication will be prepared. These will include a paper on the calf producing abilities of heifers sired by bulls from four inbred lines and a technical bulletin summarizing all the beef cattle breeding research carried out cooperatively between the Eastern Oregon and the Central Station.

6. Make enzyme studies of liver tissue from the bulls produced in crossing to determine if inbred and linecross animals differ in enzyme activity.

7. Gather physiological data on calves produced by the diallel matings. Amino acid, urea nitrogen, and creatinine of the blood will be obtained on all calves at 450 and 750 pounds and also on animals slaughtered at 1000 pounds at the time of slaughter.

8. In cooperation with the Extension Service, Dean Frischknecht, John Landers, and certain county agents, Dr. Brinks of the United States Department of Agriculture, Agricultural Research Service, Dr. Roubicek of the University of Arizona, Dr. Roland Gessert of Upjohn Company, and several ranchers, approximately 1000 cows will be used in a study of synchronization of estrus and artificial insemination. The materials for synchronizing estrus will be furnished by Upjohn Company and semen from bulls of ten inbred lines of Herefords will be provided by Drs. Brinks and Roubicek.

9. A technical bulletin will be prepared covering the studies from the initiation of the project until linecrossing was started. The material to be covered includes the selection practiced, performance of traits, and heritability estimates.

10. Cooperate with the W-1 Technical Committee and Dr. Brinks in particular in making our data available for regional technical bulletins.

VIII. Publications:

Armour and Company Seminar on Artificial Insemination. 1965. Harold White, Bernard Jones, James Bell, William Hansel, Ralph Bogart, Knowland Vandermark, George Norwood, Charles Calkins, James Wiltbank, Frank Connor, and R. O. Berry. Morris, Illinois. March.

Bogart, Ralph. 1965. Crossing lines of cattle within a breed. Oreg. Agri. Expt. Sta. Special Report 192.

Bogart, Ralph. 1965. The obligations of purebred breeders and commercial cattlemen to the livestock and meat industry. Charolais Banner. 1(5):126-139.

Bogart, Ralph. 1966. The place of crossbreeding in beef cattle. Oreg. Agr. Expt. Sta. Special Report 215.

Hoornbeek, Frank, and Ralph Bogart. 1966. Amount of selection applied and response of traits in four inbred lines of beef cattle. Oreg. Agri. Expt. Sta. Tech. B. 96.

IX. Project summary:

Oregon Agricultural Experiment Station

Cattle Inventory - June 1966				
Breed	<----------------	Hereford	---------------->	
Line	Lionheart	Prince	David	L × P
Purebred or grade		Purebred		
Bulls (12 mos. or over)				2
Cows (2 yrs. or over)	21	22	16	15
Heifers (yearlings)	3	1	1	5
Calves - bulls	3	4	4	4
- heifers	2	3	1	5
Cow Production Data - 1965 Calf Crop				
Number cows bred to calve:				
As 2-yr.olds	2	1	2	6
At 3 yrs. and up	22	21	22	0
Number calves born from				
2-year-olds - alive	2	1	2	6
3-year-olds and up - alive	16	10	13	0
- dead	1	3	1	0
Number calves weaned	18	11	15	6
Percent calf crop[a] - born	75.00	50.00	62.50	100.00
- weaned	75.00	50.00	62.50	100.00
Preweaning Performance - 1965 Calf Crop				
Birth weight - bulls	82.50	76.50	77.30	
- heifers	75.00	68.80	68.60	72.00
Weaning age - bulls	180.60	185.83	185.20	
- heifers	183.50	183.80	186.00	209.16
Weaning weight - bulls	403.20	375.67	375.60	
- heifer	369.63	329.20	362.20	397.17
Adjusted weaning weight[b] - bulls	446.58	406.53	407.49	
- heifers	404.15	359.24	392.19	390.69
Weaning score:				
Conformation - bulls	11.80	11.31	11.35	
- heifers	11.96	11.20	11.07	
Condition - bulls	10.78	10.58	10.77	
- heifers	11.29	11.03	10.50	
Average inbreeding - bulls	.0466	.0554	.1055	
- heifers	.0919	.0313	.0391	

[a] Born $= \frac{\text{Number calves born alive}}{\text{Total number cows exposed}}$ Weaned $= \frac{\text{Number calves weaned}}{\text{Number cows bred}}$

[b] 205-day weaning weight $= \frac{\text{Weaning weight - birth weight}}{\text{Age in days}} \times 205 + \text{birth weight}$

Cattle Inventory - June 1966				Total
Breed	Hereford		Angus	
Line	L × D	P × D		
Purebred or grade		Purebred		
Bulls (12 mos. or over)	2	2	2	8
Cows (2 yrs. or over)	8	6	22	110
Heifers (yearlings)	4	4	4	22
Calves - bulls	4	5	11	35
- heifers	6	6	7	30
Cow Production Data - 1965 Calf Crop				
Number cows bred to calve:				
As 2-yr.-olds	4	4	2	21
At 3 yrs. and up	0	0	18	83
Number calves born from				
2 yr.-olds - alive	4	3	2	20
3-yr.-olds and up - alive	0	0	16	55
- dead	0	0	0	5
Number of calves weaned	4	2	17	73
Percent calf crop[a] - born	100.00	75.00	90.00	72.12
- weaned	100.00	50.00	85.00	70.19
Preweaning Performance - 1965				
Birth weight - bulls	73.00	68.50	71.17	76.86
- heifers	54.00		64.00	68.41
Weaning age - bulls	194.00	196.50	170.00	182.61
- heifers	209.50		164.73	183.86
Weaning weight - bulls	425.50	366.00	438.33	395.98
- heifers	356.00		389.64	372.84
Adjusted weaning weight[b] - bulls	445.49	378.85	513.93	436.45
- heifers	349.51		469.24	410.68
Weaning score:				
Conformation - bulls			12.39	11.68
- heifers			12.05	11.71
Condition - bulls			11.22	10.82
- heifers			11.12	11.04
Average inbreeding - bulls			.1203	.0715
- heifers			.1068	.0611

[a] $\text{Born} = \dfrac{\text{Number calves born alive}}{\text{Total number cows exposed}}$ $\quad \text{Weaned} = \dfrac{\text{Number calves weaned}}{\text{Number cows bred}}$

[b] $\text{205-day weaning weight} = \dfrac{\text{Weaning weight - birth weight}}{\text{Age in days}} \times 205 + \text{Birth weight}$

Postweaning Performance - 1965 Calf Crop

Breed	Hereford					
Line	Lionheart		Prince		David	
Sex	Bull	Heifer	Bull	Heifer	Bull	Heifer
Method of feeding	Individual Feedlot					
Number on test	2	3	2	1	4	1
Average age on test	212.50	203.67	246.50	227.00	233.50	256.00
Initial weight	449.00	404.67	456.00	390.00	456.00	407.00
Initial score:						
Condition -	10.84	11.50	10.17	10.50	10.38	10.00
Conformation	11.50	12.06	11.00	11.33	10.75	10.50
Days on test	115.50	176.33	108.50	147.00	126.00	133.00
Average daily gain	3.16	1.99	3.21	2.51	2.75	2.70
Feed efficiency:						
TDN/100 lbs. gain	585.50	883.00	571.50	635.00	628.50	622.00
Final weight	812.50	753.33	803.50	759.00	806.00	757.00
Final score:						
Condition	12.25	12.50	12.00	12.17	10.92	12.33
Conformation	12.42	12.78	12.50	12.17	11.00	11.67
Average inbreeding	.2330	.2451	.1661	.1563	.2638	.1953

Carcass Data - 1964 Calf Crop

Number	3	5	1
Carcass weight	566.67	547.20	555.00
Cutability - % lean	55.68	54.90	51.55
Carcass grade[a]	High Good	High Good	Low Choice

[a]USDA bull grades

Postweaning Performance - 1965 Calf Crop						
Breed			Hereford			
Line	L × P		L × D		P × D	
Sex	Bull	Heifer	Bull	Heifer	Bull	Heifer
Method of feeding			Individual Feedlot			
Number on test	6	5	8	4	4	4
Average age on test	218.50	208.80	207.50	188.00	225.50	253.75
Initial weight	449.00	401.20	449.50	402.25	454.50	400.75
Initial score:						
Condition	10.80	11.17	10.90	11.21	10.88	10.58
Conformation	11.75	11.93	11.86	11.58	11.50	10.75
Days on test	106.17	152.60	119.00	166.25	119.00	156.33
Average daily gain	3.38	2.35	3.05	2.13	3.00	2.36
Feed efficiency:						
TDN/100 lbs. gain	522.66	724.40	601.63	787.50	608.75	711.67
Final weight	807.50	756.00	810.25	753.00	810.50	754.00
Final score:						
Condition	11.83	12.67	11.58	12.29	11.42	12.06
Conformation	12.33	13.10	12.00	12.29	11.87	11.83

Carcass Data - 1964 Calf Crop			
Number	4	4	4
Carcass weight	565.75	560.75	564.25
Cutability - % lean	53.08	54.07	55.67
Carcass grade[a]	Low Choice	Low Choice	High Good

[a]USDA bull grades

Postweaning Performance - 1965 Calf Crop			Total
Breed	Angus		
Line	Bull	Heifer	
Method of feeding	Individual	Feedlot	
Number on test	6	11	61
Average age on test	174.67	175.55	206.70
Initial weight	448.33	408.55	428.77
Initial score:			
Condition	11.22	11.12	10.93
Conformation	12.39	12.06	11.69
Days on test	134.17	183.91	140.18
Average daily gain	2.77	1.93	2.61
Feed efficiency:			
TDN/100 lb. gain	690.00		656.43
Final weight	816.00	756.82	784.60
Final score:			
Condition	12.25	12.12	11.98
Conformation	12.86	12.50	12.31
Average inbreeding	.1203	.1068	.0793

Carcass Data - 1964 Calf Crop			
Number	10		31
Carcass weight	563.50		560.94
Cutability - % lean	54.38		54.54
Carcass grade[a]	Avg. Choice		Low Choice

[a]USDA bull grades

UTAH STATE UNIVERSITY

I. Station: Utah Agricultural Experiment Station, Logan

II. Project title: The development of breeding techniques and selection criteria for improvement of economically important characteristics in Hereford and Shorthorn cattle.

III. Personnel:

Experiment Station:
James A. Bennett, Project Leader, A. J. Nyman, William J. Nay, and Keith G. Mikesell

U. S. Department of Agriculture, Agricultural Experiment Station, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year:

Linecross calves were again produced in the Hereford cattle this year. The linecrosses again involved the Colorado Brae Arden and the Montana Havre Line II crosses. Only one bull from each of the cross sources was used this year. The better bull of the two used the previous year in each of the two outside lines was used to produce these calves. A summary of the average birth weight and the average daily gain from birth to weaning is given in table 1. The differences are not significant. It is interesting to note, however, that the Brae Arden crossline calves were again the heaviest at weaning time and the Montana crossline calves this year are much lower than last year. There was more difficulty with scours in all the calves and summer gains, although feed appeared to be good, were down considerably from the previous years. A more sophisticated analysis of variance will be made of the two years' data on the crossline calves.

Table 1. Average Birth Weights and Daily Suckling Gains on Crossline and Straightline Hereford Calves - 1965

Sire line	Average birth weight	Average daily gain birth to weaning
	lbs	lbs.
Colorado Brae Arden	80.4	1.58
Montana Havre Line II	82.2	1.52
Utah Line I (Control)	80.5	1.42

Further studies were made with the Branson Sonoray Model No. 12 machine for measuring outside fat thickness in live cattle. Testing was conducted with different settings of the machine as it is felt that the recommended setting of 3.28 for fat and 3.74 and 3.62 for minimum and maximum marbling

may not give the ultimate in accuracy. This work has not yet been completed as more animals will need to be checked. As the calves from this year's crop attain sufficient size and finish to be slaughtered they will be included in this study.

Some detailed cooking studies were conducted on animals from different sires. These tests have not been completed and further work will be done in the near future. A summary of the results to date is given in table 2. These tests were run on prime rib roasts cooked at a 325° temperature to an internal temperature of 165°. The numbers are limited in these groups and not much weight can be attached to these results but they are probably indicative of what will be found with larger numbers as the tests proceed. It does not appear that any outstanding difference is present in tenderness ratings on these sires. All of them are definitely in the acceptable level but as yet there are no indications that any one sire is outstanding in this respect. There appears to be some difference in juciness. The correlation between the panel and the Orchard Press measure of juiciness appears to be low. As more data become available these items will be checked in more detail.

Table 2. Beef Cooking Results (Preliminary)

Sire	Tenderness measures: Warner-Bratzler[a]	Tenderness measures: Panel[b]	Juiciness: Orchard[c] Press	Juiciness: Panel[b]	Over-all[b] panel rating
N19	13.12	7.25	4.1	6.37	6.90
M105	12.15	7.76	2.06	6.34	7.46
M127	10.62	7.76	0.4	6.00	6.90

[a]Low score most tender
[b]High scores most acceptable with a range of 1 to 9
[c]High scores most juicy

V. and VI. Summary of progress and conclusions to date and application of findings:

The results of this project indicate that a system of mild inbreeding accompanied by selection on the basis of performance is a rather effective tool for improving performance in beef cattle. There does not appear to be any serious deterioration resulting from inbreeding when selection on the basis of performance is stressed. Some decrease in weaning weight has occurred in the Shorthorns as the inbreeding coefficient becomes more advanced. No marked decrease is evident, as yet, in the Hereford lines. It would, thus, appear that mild inbreeding accompanied by selection can be carried on for several generations without any serious reduction in performance characteristics. There has not been any loss in carcass merit with the system of breeding.

This project has also provided and demonstrated techniques for performance testing that can be applied by purebred breeders in their own herds. Many breeders have undertaken such a project under the supervision of the Extension Service and some 1000 head of cattle are now on some type of

performance test in the state each year. This project has also provided and is providing more information concerning refined measurements of performance characteristics in cattle. This information as it has become available has provided more accurate methods of measuring performance.

VII. Work planned for the future:

The crossline and the straightline cattle produced in the Hereford herd during the past summer will be put through the postweaning performance test. At the conclusion of these tests, carcass data will be obtained and as far as possible cooking tests will be made to evaluate tenderness, juiciness, and flavor of the meat of these cattle.

The mating program will be designed to propagate the lines of cattle that have been established. After two years of line crossing in the Herefords, it will not be necessary to produce straightline cattle so that the lines can be maintained.

Further testing will be done with the Model No. 12 Sonoray for measuring outside fat. This year particular attention will be given to try to develop means of estimating total amount of fat in the carcass from measurements on the live animals. To date, the machine has been tested for accuracy for measuring fat in specific locations. Now, exploratory studies will be initiated to try to devise means of estimating the total amount of fat in the carcass.

Data that have been accumulated over the years of the project are being put together for statistical analysis. Much of the Utah data are being pooled with data from other stations in the region and the pooled data will be analyzed. Particular attention will be given to measuring the effects of inbreeding and selection. In addition to the analysis of pooled data, separate analyses will be run on the Utah cattle to determine the effects of inbreeding in this herd and to try to obtain more detailed information on growth.

IX. Project summary:

Cattle Inventory - June 1966					Total
Breed	Panguitch Hereford	Logan Hereford	Logan Shorthorn	Logan Hereford Dwarf Carrier	
Line	I	II	I	II	
Bulls (12 mos. or over)	10	1	2		13
Cows (2 yrs. or over)	54	21	23	13	111
Heifers (yearlings)	26	2	7	4	39
Steers (yearlings)		5	3		
Calves - bulls	30	9	11		50
- steers				8	8
- heifers	18	10	14	5	47

Cow Production Data - 1966 Calf Crop						
Breed	<-----------Hereford-----------			-->	Short-horn	Here-ford
	Straight-line	Cross-line	Cross-line	Straightline		Dwarf carrier
Line	Utah	Colorado	Montana	Utah	Utah	Utah
	I	I	I	II	I	II
Station	<------Panguitch		------->	<-------Logan		-------->
Number cows bred to calve						
As 2-yr.-olds	8	0	0	3	5	0
At 3 yrs. and up	23	12	17	13	30	13
Number calves born from						
2-yr,-olds - alive	8	0	0	2	4	0
- dead	0	0	0	0	2[c]	0
3-yr.and up - alive	19	10	15	13	27	11
- dead	4	0	0	0	2	0
Number calves weaned	26	10	14	13	24	10
Percent calf crop weaned[a]	83.9	83.3	76.5	81.3	58.5	76.9

Preweaning Performance - 1966 Calf Crop						
Birth weight - bulls	79.7	78.0	83.8	66.2	61.2	74.4
- heifers	73.5	81.0	78.5	62.7	61.0	66.8
Weaning age - bulls	213.0	186.0	211.4	251.5	263.1	251.8
- heifers	213.5	216.0	221.8	231.5	267.5	247.0
Weaning weight - bulls	359.0	385.0	415.0	404.2	432.7	400.0
- heifers	340.0	421.0	391.6	316.3	364.0	388.3
Adjusted weaning[b] weight - bulls	349.3	415.0	406.5	339.8	344.3	377.0
- heifers	331.0	402.3	367.5	296.3	292.0	322.6
Weaning score:						
Conformation - bulls	2.8	2.7	2.8	2.2	2.1	2.1
- heifers	2.1	1.7	2.0	2.0	2.2	1.9
Condition - bulls	2.0	2.0	1.9	3.3	3.6	3.3
- heifers	2.7	2.4	2.6	3.3	3.8	3.1

[a]Based on number of calves at weaning
[b]Adjusted to mature dam, 205 days of age
[c]One set of twins - 5 cows calved

Postweaning Performance - 1966 Calf Crop

Breed	<--------------	Hereford	-------------->	Shorthron
Line	Straight-line Utah I	Crossline Colorado I	Crossline Montana I	Straightline Utah II	Straightline Utah I
Station		Panguitch			Logan
Sex			Bulls		
Method of feeding			Individual Feedlot		
Number on test	3	1	7	3	7
Average age on test	312	300	296	302	306
Initial weight	522	529	507	568	537
Initial score:					
Condition	2.0	2.0	1.9	2.0	1.9
Conformation	2.8	2.7	2.8	3.0	3.3
Days on test	107	105	107	107	108
Average daily gain	2.84	2.85	2.92	2.85	2.89
Final weight	827	828	819	873	847
Final score:					
Condition	1.8	2.0	1.9	1.8	1.6
Conformation	3.0	3.0	2.9	2.8	2.6

WASHINGTON STATE UNIVERSITY

I. Station: Washington Agricultural Experiment Station, Pullman

II. Project title: Comparison of breeding systems for improvement of beef cattle

III. Personnel:

Experiment station:
C. C. O'Mary, Project Leader, Douglas D. Bennett, Herdsman, and S. K. Shah, Graduate Student

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year:

Two experiments were conducted with the Angus herd in this project. The first experiment involved the cow herd; the second, the 1964 and 1965 calf crops.

In the first experiment, 78 cows were randomly divided within age and breeding groups into two treatment groups of 39 cows each. Group 1 was fed peavine silage *ad libitum* plus as much hay as they would clean up in a 24-hour period. Group 2 was fed only peavine silage *ad libitum*. Weight changes on the cows were determined over a 98-day period before calving, but the groups were maintained on their respective rations until after calving. On a dry matter basis, the average daily feed consumption per cow was 19.7 pounds for Group 1 and 13.8 pounds for Group 2. After 27 days on their respective rations, the two groups did not differ significantly in weight gains. At 53 days and at 98 days, weight gains did differ significantly in the two groups. Over the entire test (October 3, 1964 to January 9, 1965), the weight gains for cows in Group 1 averaged 130 pounds per cow compared to an average 86 pounds per cow for Group 2. Mineral consumption in Group 2 was twice as great as in Group 1.

Calculated on current feed costs, the cost of feeding a cow was 8 cents less per day per cow for those in Group 2 compared with Group 1.

Birth weights were taken on the calves. Birth weights were significantly affected by ration of the dam, sire, and sex of the calf. The male calves in Group 2 averaged 3 pounds lighter and the females 8 pounds lighter from cows fed silage alone than those fed both silage and hay. There were no significant interactions. These calves were performance tested on a pelleted ration. While the dam's ration significantly affected birth weights, postweaning traits of these calves were not significantly different in the two groups.

The second study involved two calf crops (1964 and 1965). These calves were placed on feed tests and feed consumption and weight gains were

kept on a weekly basis. The ration consisted of 50 percent alfalfa and 50 percent concentrates together in a pelleted form. Two additional pounds of alfalfa hay per head daily was allowed as this had been found to reduce bloat hazard.

Several different analyses were performed on the data to determine if ration of the dam (silage vs. silage plus hay),sire, sex, and year had any effect on initial weight, average daily gain, and feed efficiency, or if there were significant interactions. The results indicated that sire affected initial weight and daily gain in the feedlot, but did not significantly affect feed efficiency. There was a significant difference between the bulls and heifers in daily rate of gain, but not in feed efficiency. While ration of dam affected birth weights, it did not have a significant effect on postweaning traits. There was not a significant year effect on the traits studied but a difference in feed efficiency approached the .05 level of significance.

Other factors affecting growth and feed efficiency which were studied were temperature and management factors. Maximum and minimum daily temperatures were kept and these averaged on a weekly basis and plotted against gains and efficiency. The results indicated that in the early part of the test (first nine weeks) the fluctuation in environmental temperature outside the comfort zone (30° to 60° F.) adversely affected rate and efficiency of gains. Also, the physical or physiological stress produced through vaccination, spraying, or other medication affected gains and efficiency.

A cooperative effort with the Hawaii Station was begun. Semen was collected from three Angus herd sires and shipped to Hawaii to be used in a commercial herd. Offspring from the bulls will be produced in Washington and Hawaii.

V. Summary of progress and conclusions to date:

Sufficient data have been collected on the herd sires in Groups 1 and 2 to make a good comparison between the two herd bulls. Progeny sired by Tessadas' Eileenmere 6 were superior to those sired by Eileenmere 100 in all traits studied except conformation score in the 1964 calf crop. In the 1965 calf crop, the male progeny of Tessadas' Eileenmere 6 were superior in every respect to those sired by Eileenmere 100. The adjusted weaning weights were heavier by an average of 54 pounds and daily feedlot gains were 0.29 of a pound better. The heifer progeny were also superior in weaning weights and feedlot gains.

A very successful sale was held in March. The prices paid indicate good acceptance of the cattle by the industry.

VI. Application of findings:

For performance testing work, the cows in the herd all should be fed alike. A significant effect on birth weight has been found where different rations are fed. While this difference was not significant in postweaning traits, one cannot be certain that some of the effects have not remained

and that small numbers or rather great variations have made the effects impossible to detect.

In two (or more) sire herds, bulls can be compared easily by keeping records on their progeny.

Close attention should be given to management practices that invoke stress on animals as these definitely affect growth and efficiency of calves.

VII. Work planned for the future:

Routine procedures will continue to be followed in collecting birth weight, weaning weights and grades, and feedlot gains and efficiency.

Cooperation with the Colorado and Hawaii stations will be continued on those phases of the project already started. No new experiments are planned as the project leader will be on sabbatical leave.

The new test barn should be ready for use in September.

VIII. Publications and manuscripts:

Sellers, Halliburton Ian. 1965. Comparison of silage vs. silage plus hay as roughages in winter rations of beef cattle. M. S. Thesis. Washington State University. Pullman.

Shah, S. K. 1966. Factors affecting the growth and feed efficiency in beef cattle. Ph. D. Thesis. Washington State University. Pullman.

IX. Project summary:

Washington Agricultural Experiment Station

Cattle Inventory - June 1966					Total
Breed	<-----------------		Angus		----------------->
Line	A	B	C		
Purebred or grade			Purebred		
Bulls (12 mos. or over)	2	10	8		20
Cows (2 yrs. or over)	20	20	20		60
Heifers (yearlings)	15	7	9		31
Calves - bulls	8	6	9		23
- heifers	10	11	9		30
Cow Production Data - 1965 Calf Crop					
Number cows bred to calve:					
As 2-yr. olds				12	12
At 3 yrs. and up	20	20	20		60
Number calves born from:					
2-yr.-olds				12	12
3-yr-olds and up - alive	18	17	18		53
- dead	2	1	1		4
Number calves weaned	18	17	18	11	64
Percent calf crop[a] - born	90	85	90	100.0	90.3
- weaned	90	85	90	91.7	88.9
Preweaning Performance - 1965 Calf Crop					
Birth weight - bulls	69.1	56.5	68.4		64.7
- heifers	70.2	58.3	60.3		62.9
Weaning age - bulls	210.4	196.8	179.6		195.6
- heifers	198.9	199.4	197.1		198.5
Weaning weight - bulls	459	371	455		428
- heifers	398	366	400		388
Adjusted weaning weight[b] - bulls	404.5	350.6	443.4		399.5
- heifers	367.7	335.6	372.4		358.6
Weaning score:					
Conformation - bulls	88.5	87.5	89.7		88.6
- heifers	88.8	89.5	89.3		89.2

[a] Born $= \dfrac{\text{Number calves born alive}}{\text{Number cows exposed}}$ Weaned $= \dfrac{\text{Number calves weaned}}{\text{Number cows exposed}}$

[b] $\dfrac{\text{Weaning weight - birth weight}}{\text{Age in days}} \times 180 + \text{Birth weight}$

Postweaning Performance - 1965 Calf Crop				Total
Breed		Angus		
Line	A	B	C	
Sex		Bulls		
Method of feeding	Individual	Individual		
Number on test	7	5	8	20
Average age on test	225.4	211.8	194.6	210.6
Initial weight on test	530	439	487	485
Initial score - conformation	88.5	87.5	89.7	88.6
Days on test	149	149	149	149
Average daily gain	2.07	1.78	2.17	2.01
Feed efficiency:				
Lbs. feed/100 lbs. gain	669	702	635	669
Final weight	839	704	812	785

Sex		Females		
Method of feeding		Individual		
Number on test	10	11	9	30
Average age on test	213.9	214.4	212.1	213.5
Initial weight	448	408	413	423
Initial score - conformation	88.8	89.5	89.3	89.2
Days on test	149	149	149	149
Average daily gain	1.55	1.41	1.54	1.50
Feed efficiency:				
Lbs. feed/100 lbs. gain	768	759	728	752
Final weight	679	618	642	646

UNIVERSITY OF WYOMING

I. Station: Wyoming Agricultural Experiment Station, Laramie, and Gillette Substation, Gillette

II. Project title: Criteria for improving effectiveness of selection in beef cattle. W.S. 655

III. Personnel:

Experiment Station:
G. E. Nelms, Project Leader, R. A. Field, and
C. O. Schoonover, Animal Science Division
Leon Paules, Substation Division
W. W. Ellis, Biochemistry Division

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
J. S. Brinks, Investigations Leader

IV. Nature and extent of work done this year:

The recent revision of the project necessitated the elimination of the Shorthorn cows. These were replaced by the purchase of 30 heifer calves which will be used to enlarge the two Hereford lines. The first calves from the lines were dropped this spring. Bulls are being evaluated at a weight of approximately 950 pounds. Data being collected include somascope data on live animals and the carcass, area rib eye, depth of round, and retail cut-out with a uniform trim.

The Wyoming station is cooperating in the regional genetic-environment interaction project. In addition to providing a sire from the Gillette line, a cooperator herd was enrolled.

In the cooperator herd, yearling Hereford, Angus, and crossbred heifers were used. The heifers were assigned randomly within breed type as they came into heat. The calving data are summarized as follows:

Bull number	Number bred	Number calved
4	35	28
0006	37	15
33	37	15
71	37	19
307	34	18
311	36	20
	216	115

Most heifers were bred only once. The breeding dates were July 14 to August 6,1965.

The relationship between live weight and l. dorsi was studied using 354 bulls. An equation was developed which could be used in selecting

bulls. The weight range studied was from 94 to 589 kg. Area of l. dorsi increased in a linear manner as weight increased. It is clear from these data that a standard figure of 2 sq. in. per 100 lbs. is not suitable as a standard in evaluating animals of different weights. The estimating equation arrived at was:

$$Y = 18.42 \div 0.1307X$$

where Y = estimated l. dorsi area in sq. cm. and X = live weight in kg. The standard error of the estimate was 9.40 sq. cm. The following table lists the predicted l. dorsi for some weights:

Live weight	l. dorsi area
pounds	sq. in.
700 - 749	9.52
750 - 799	9.98
800 - 849	10.43
850 - 899	10.90
900 - 949	11.36
950 - 999	11.81
1000 - 1049	12.28
1050 - 1099	12.74
1100 - 1149	13.19
1150 - 1199	13.66
1200 - 1249	14.10
1250 - 1299	14.57

V. Summary of progress and conclusions to date:

The revisions indicated last year have been incorporated.

VI. Application of findings:

The analysis of the carcass data of bulls revealed an equation for adjusting l. dorsi area. It also indicated the standard 2 sq. in. per cwt. of carcass is not justified.

VII. Work planned for the future:

Continue as outlined.

VIII. Publications:

Field, R. A., C. O. Schoonover, and G. E. Nelms. 1966. Adjusted longissimus dorsi areas in bulls of different weights. Amer. Soc. Anim. Sci. West. Sect. Proc. 17:139-144.

Field, R. A., C. O. Schoonover, and G. E. Nelms. 1966. Relationships between carcass weight and muscle fat and bone in bull carcasses. Amer. Soc. Anim. Sci. West. Sect. Proc. 17:169-174.

IX. Project summary:

Wyoming Agricultural Experiment Station

Cattle Inventory - June 1966				
Breed	Hereford	Hereford	Shorthorn	Angus
Line	Gillette	Laramie		Laramie
Purebred or grade	Purebred	Purebred		Purebred
Bulls (12 mos. or over)	3	2		
Cows (2 yrs. or over)	31	51		38
Heifers (yearlings)	9	38		9
Calves - bulls	9	26		19
- heifers	21	16		17

Cow Production Data - 1965 Calf Crop				
Number cows bred to calve:				
As 2-yr.-olds	8	12	8	10
At 3 yrs. and up	32	48	22	33
Number calves born from:				
2 yr.-olds - alive	4	10	6	9
3 yr.-olds and up - alive	28	39	19	29
- dead	2	2	1	1
Number calves weaned	29	47	22	35
Percent calf crop[a] - born	80	85	87	91
- weaned	73	78	73	81

Preweaning Performance - 1965 Calf Crop				
Birth weight - bulls	75	82	71	58
- heifers	71	73	69	56
Weaning age - bulls	163	186	178	196
- heifers	171	188	179	203
Weaning weight - bulls	369	407	322	397
- heifers	361	361	334	401
Adjusted weaning weight[b] - bulls	400	397	324	368
- heifers	376	348	335	362

[a] $\frac{\text{Number born}}{\text{Number cows exposed}}$

[b] For age only

* Divided into two lines for 1966 calf crop.

Postweaning Performance - 1965 Calf Crop

Breed	Hereford				
Line	Gillette		Laramie		
Sex	♀	♂	♀	♂	♀
Method of feeding	Group - Feedlot				
Number on test	16	13	11	14	30[a]
Average age on test	201	193	198	196	173
Initial weight	379	397	361	407	367
Days on test	168	168	168	168	112
Average daily gain	1.53	2.36	1.21	2.41	1.85
Final weight	636	793	565	812	574
Average inbreeding	12.5	12.6			

[a]These heifers purchased to replace Shorthorns

Breed	Crossbreds		Shorthorn		Angus	
Line			Laramie			
Sex	♀	♂	♀	♂	♀	♂
Method of feeding	Group - Feedlot					
Number on test	16	25	9	8	9	16
Average age on test	188	196	189	188	213	206
Initial weight	379	411	334	322	401	397
Days on test	168	168	168	168	168	168
Average daily gain	1.40	2.51	1.28	2.35	1.18	2.39
Final weight	616	833	501	716	599	799

PROJECT REPORTS AND DISCUSSIONS

PROJECT REVISIONS

and

BUSINESS MEETING

PROJECT REPORTS AND DISCUSSION

Arizona

Dr. Roubicek discussed the line testing project being conducted at San Carlos. Ten inbred Hereford bulls from ten different lines developed at experiment stations in the Western region are being used each year. The first calves were born in the spring of 1966. The following table lists the results:

Sire	Total cows	Cows not bred	Calves died	Live calves	Live calves at birth
Project sires:	no.	no.	no.	no.	%
Bozeman 114	28	9	1	18	64
Colorado 9068	28	5	2	21	75
Royal 0006	28	15	1	12	43
Miles City 1423	28	4	1	22	79
Miles City 9250	23	1	1	21	91
Utah 0119[a]	33	7	1	25	76
Wyoming 71[a]	27	5	3	19	70
Outside sires:					
SC 8123	28				89
Havre	29				86
SC 877	28				93
Colorado 30	28		4		64[b]
UA 325	30				83

[a]Used again in 1966 in the excess breeding pastures.
[b]Dwarf carrier bull

Semen collection was more successful this year, with satisfactory semen being stored from 9 of the 10 bulls. Only the Utah bull failed to freeze.

The feeding facilities at Tucson are complete. One-half of the bull calves by the inbred sires will be fed for 140 days with the other half remaining on the range comparable with the heifers. This will provide a measure of interaction between the genotypes of the bulls and feedlot versus range environment. Many of the better bulls will be used in their commercial herd.

The Arizona station would like to obtain bulls to be used next year during October 1966 in order to get them acclimated.

The Arizona rat project is continuing. Animals are raised under two distinct environments--22° and 35° C--for a 13-week period. Dr. Ray has been transferring animals between environments at different stages of gestation and has been getting animals to reproduce at 35°. Two sisters finally produced their last litters at this temperature, although they did not mother their litters.

Colorado - Lipid Project

Dr. Cramer reviewed their initial work on the genetics of fat composition and distribution. This is a three-year project designed to estimate heritabilities of the various lipids in the blood and muscle and the genetic relationships among them. The ultimate goal is to provide information that will aid in selecting cattle that have the desired quality of fat without excess fat covering.

The chemical techniques are quite complex but have been worked out recently and are now working quite smoothly.

Referring to the report which was distributed, the iodine number is based on the degree of unsaturation of fat and with increasing number of double bonds an increased softening of the fat and lowering of the melting point occur. The higher the iodine number the softer the fat. Pork runs in the high 50's, beef in the 40's, and mutton in the 30's.

The Colorado station would like to obtain performance data on the animals from which samples were already sent and to obtain samples of feed in the future.

Hawaii

Dr. Cobb gave a short report this year with the understanding he would have more time next year when several analyses will have been completed. They have completed the first five years of progeny testing with the last animal slaughtered the week before the meeting. Half of each sire group has been fed in the feedlot and the other half on pasture, with both groups being slaughtered at 1000 to 1050 pounds live weight. Data on the interactions still appear about as they did after three years' data. It appears that a negative correlation between genotype of the steers and feedlot versus pasture may exist although the data have not been analyzed.

Hawaii is continuing to use semen from bulls from the inbred lines being tested in Arizona and is interested in the genetic-environmental interaction aspect of the work. The first year was spent in educating the ranchers on artificial insemination procedures.

An analysis was completed on predicting empty body weight using live weight minus stomach and intestine fill. Prediction equations were obtained. Lofgreen's equations overestimate empty body weight in the range of their data.

Work on fat compostion from the *longissimus dorsi* shows a large difference in composition between pasture and feedlot cattle.

Idaho

Dr. Christian discussed recent results on the Idaho progeny testing program. Under this program, the University leases bulls to cooperting ranchers and steers are brought back to University feedlots or fed in commercial feedlots. Carcass data are obtained.

A recent analysis showed that farm differences on scores and performance traits decrease from about 30 to 10 percent of the total variation from initial measures to final measures before slaughter.

Recently, they have gone to larger groups of bulls and have concentrated on two ranches. One uses two Hereford, two Angus, and two Shorthorn bulls, and the other uses six Hereford bulls.

The Idaho station is studying the effects of some tranquilizers and depressing drugs on fertility.

Nevada

Dr. Bailey reported on the continuing project involving five lines of Hereford cattle, three of which are at Reno and two at Knoll Creek. Much time during the past year was spent analyzing the first ten years' data. Emphasis in current analyses is on selection intensities and time trends. Locations and sexes are being analyzed separately. Inbreeding effects are not quite the same at the two locations.

Half of the bulls from each line were slaughtered at the end of the performance test and the other half when they reached 1000 pounds live weight to obtain information on feed conversion, energy conversion, and body composition. A new meats laboratory is under construction which should aid in the collection of meats data.

They are continuing to participate in the line testing program with Arizona and other stations by furnishing two bulls each year.

The rat project will be completed this year. They are now in the fifth generation and realized heritabilities appear to be around 0.3 to 0.5.

New Mexico

Dr. Holland discussed recent work with the two lines of Hereford cattle, the Old Line, closed since 1932, and the Outcross Line, closed since 1941. Heart defects have been noted in both lines. Matings were made to determine if the defects are genetic or simply inherited, and no abnormal calves were born during the year. The matings are being repeated this year.

Oregon

Dr. Bogart stated that the first 12 years of work covering the effects of inbreeding and selection in four lines of cattle was completed during the year. This material will be published in a technical bulletin.

Diallel matings among the three Hereford lines are continuing with all possible inbred and reciprocal crosses being produced. Data on rate of gain, feed efficiency, blood, chemical studies, liver, and enzyme activity are being collected. Bulls are fed to 1000 pounds live weight and carcass and organoleptic data are being obtained.

The inbred and linecross heifers are mated to the same Angus bull until two calf crops are produced to evaluate maternal ability.

Studies on synchronization of estrus are being carried out. Last year, 100 head were implanted in the ear with material used for birth control in humans. Eight days after implantation, the material was scraped out. Another herd of 100 head were fed material for synchronization. The cattle were inseminated and 53 conceived that received implants and 49 that had been fed the material. This year, 1000 head in one herd and another 1000 head scattered over the state are being used for the same studies. The same bulls are being used at different locations so information on genetic-environmental interactions will be obtained.

A selection experiment with mice is being initiated. Genetic parameters have been established in the base population and the selection lines are about to be formed. Selecting on the basis of an index will be compared to selecting the elite in each trait and then randomly mating the elite. The traits proposed are litter size, weaning weight, growth rate, and body composition (fatness). In each of the two groups, two lines will be selected for high performance and two for low performance. Also, two lines of the same population size will be unselected controls.

Washington

Dr. Hillers reviewed progress at the Washington station for Dr. O'Mary, who is on sabbatical leave. In one study, cows were divided into two groups with one group being fed peavine silage ad libitum plus hay and the second only silage ad libitum. Birth weights of calves were affected significantly by ration of dam with the male calves in Group 2 averaging three pounds lighter and the females eight pounds lighter.

A second study dealt with the effect of temperature on performance. Fluctuation in temperature outside the comfort zone of 30° to 60° F. adversely affected rate and efficiency of gain.

Wyoming

Dr. Nelms reported on the Wyoming project. Semen from the bulls in the Arizona line testing project was used in a cooperator herd and 115 calves were born from these matings. Drought conditions prevented continuing the study this year.

The Shorthorn herd has been eliminated and 30 heifers were purchased to increase the size of the Hereford lines. They were half sisters by half sister dams.

A study on rib-eye area indicated that a figure of two square inches per 100 pounds carcass weight is not an adequate comparison over large weight ranges.

PROJECT REVISIONS

California

Dr. Rollins discussed their proposed study dealing with double muscling and distributed the following background material:

Research in Bovine Muscular Hypertrophy

A progress report on the design of a new research project for submission to W-1. Abstracted from the California Agricultural Experiment Station Annual W-1 Report (Section VII) for July 1965-June 1966.

A new breeding project at Davis dealing with muscular hypertrophy is being designed. There is a mutant gene in domestic cattle that causes easily discernible changes in form primarily due to muscular enlargement but also to reduction in the amount of subcutaneous, extra-muscular, and intra-muscular fat, thinning of the hide, and possibly some modification in the skeleton.

This gene has been found in all cattle breeds but is scarce in most. It is of relatively high frequency in the Charolais breed,where it appears to tend towards dominance. This means that the condition may sometimes be spotted in heterozygotes in slight manifestation in addition to strong manifestation in the homozygotes. Among the British breeds the gene turns up more often in Angus than in Shorthorns or Herefords and its dominance or recessiveness is not clear.

The mutant phenotype (sometimes called the double muscle condition) can be described as follows: From birth to maturity there is excessive muscle development, especially in the hind quarters, associated with reduced subcutaneous fat and thinning of the hide all in concert, giving rise to visible inter-muscular grooves, particularly in the outside of the thigh. Also, the shape of the rump tends to resemble that of a Quarter horse. In fact, in Italy the condition is called "horse rump" by breeders instead of "double muscle" as in this country.

Preliminary phenotypic studies, test matings, and pedigree and progeny studies are currently under way at Davis to devise a grading system (based on visible inter-muscular grooves and rump shape) for phenotypically detecting the presence of the mutant gene in the heterozygote. In the project under design it is hoped to correlate such a system with extensive carcass and offal measurements, and progeny and pedigree information.

The literature and some of our own data indicate that this gene significantly increases the lean to fat and lean to bone ratios. Hence, it could be of great value to the beef industry provided no unmanageable, undesirable side effects exist. There is some evidence that the gene,

especially in homozygous form, might lead to parturition problems. Also, little is known about the eating and keeping quality of the meat. Experience in Italy shows that it might be practical to use homozygous mutant bulls on large, roomy normal cows and market the heterozygous calves.

The project being designed will attempt to throw light on the above considerations and work out a system for phenotypically identifying the presence of the gene in the live animal so that the gene could be "plugged" "into" or "out of" a breeding operation when and where desired.

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Dr. Warwick mentioned that J. M. Rendel, Commonwealth Scientific and Industrial Research Organization, Brisbane, is studying this condition with the hope of selecing normal segregates that will have a greater amount of muscle.

Dr. Rollins will prepare a formal project outline and distribute it to the W-1 Technical Committee for comments and approval.

Arizona

Dr. Roubicek explained the opportunity for expanding the Arizona work in the area of cow maternal ability and over-all productivity. He introduced Dr. Donald Ray, who will be responsible for this phase of the work.

Dr. Ray distributed and discussed the following prepared supplement along with material on udder evaluation.

Arizona Agricultural Experiment Station

I. Proposed supplement to project W-1. "Direct evaluation of females for production factors."

II. Objectives:

1. To develop a descriptive model of maternal characteristics

2. To find the repeatability or progressive change of the characteristics with increasing age

3. To determine relationships of the various characteristics to maternal producing ability

4. To establish genetic parameters of those characteristics which appear to be associated with actual or potential producing ability

III. Justification:

The real value of the breeding cow depends upon her fertility, longevity, weaning weight and quality of her progeny. This proposed study is an attempt to associate characteristics of the female with these performance factors.

IV. Procedure:

The entire tribal cow herd at San Carlos will be included in the study. This includes approximately 500 registered and 500 nonregistered Hereford cows 3 years old and older together with replacement heifers.

Progeny weaning records will be obtained for all breeding cows.

Individual female evaluation will be conducted about July 1. This is the completion date for the breeding season, and the lactating cows should be at or near peak milk production.

Cow Evaluation Data:

A. Identification:
1. Cow number
2. Sire
3. Dam

B. General:
1. Date
2. Weight
3. Lactation status

C. Score:
1. Udder
2. Type
3. Condition
4. Size
5. Femininity
6. Structural soundness

D. Measures of meatiness

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After explaining their objectives and procedures, Dr. Ray asked the Committee members for comments and suggestions.

Problems associated with scoring of udders for size, soundness, etc., were discussed. The importance of scoring the udder at parturition was mentioned. Other items mentioned for possible consideration were repeatability of weaning weight, longevity, life time production, most probable producing ability, quantity and composition of milk, and calving as two's versus three-year-old heifers.

The Arizona station will distribute the supplement to the W-1 Technical Committee after additions and revisions are incorporated.

U. S. Range Livestock Experiment Station

Dr. Pahnish explained in detail the following proposed project revision that was distributed to the Committee earlier:

U. S. Range Livestock Experiment Station

Project Title: Development of superior lines of beef cattle (AH d1-2)

The following is an extension of that portion of the over-all project devoted to an evaluation of the merits of crossing inbred lines of beef cattle. The Hereford lines developed on the Station are used. Phase 1 of the linecrossing study was designed to measure hybrid vigor in two-line crosses. Phase 2 was designed to evaluate maternal qualities in crossline

females produced in phase 1. Phase 3, to be initiated during the 1966 breeding season, provides a comparison of methods of maintaining hybrid vigor.

Phase 3 - Comparison of methods of maintaining hybrid vigor:

The results from phase 1 of the linecrossing study have generally shown heterosis for several traits of economic importance in the first cross offspring. Additional information is needed on subsequent generations produced under systematic crossing procedures and on methods of maintaining hybrid vigor over an extended period of time. To provide this information, the following will be compared:

1. Straightline breeding
2. Two-way rotational crossing
3. Three-way rotational crossing
4. Development of a synthetic variety

Increases in performance within the straightline population will be due primarily to additive genetic variation. This system will serve as a base point for comparisons with the other three systems. The differences in performance of animals produced under the two-way and three-way rotational breeding systems, relative to the straightline population, will be due primarily to nonadditive genetic variation or interactions of additive variation with environmental influences such as maternal environment provided the calf and will constitute the measures of hybrid vigor. The difference in performance of the synthetic variety and the straightline population will be due to a combination of additive and nonadditive genetic variation. Comparisons among the four systems will indicate which systems are superior. Trends over the years in the latter three systems, relative to the first system, will indicate how long hybrid vigor can be maintained and whether method 4 is able to utilize the additive genetic variation created by linecrossing. This study will parallel the breed crossing study under way at the Station.

The straightline dams used in phase 1, along with straightline replacement females on the Station, will be available for phase 3 in the breeding season of 1966. Straightline and crossline females produced in phase 1 will become available in the following breeding seasons after producing two crops of calves each in phase 2 (study of maternal qualities): 1966 season--1962 females; 1967 season--1963 and 1964 females; 1968 season--1965 females.

The following scheme will apply when the full complement of animals becomes available (breeding season of 1969 and thereafter, assuming replacement heifers can be bred to calve successfully at two years of age). If studies currently in progress indicate that breeding replacement heifers to calve at two years of age is not desirable, the following time schedule for assembling a full complement of females will be delayed about one year

Breeding Plans for 1969 to End of Project

Line of sire	Line of dam: 1	4	6	10	1×4	1×6	1×10	4×6	4×10	6×10	SV	Total
1 (2 sires)	30				5	5	5	/5/	/5/	/5/		: 60
4 " "		30			5	/5/	/5/	5	5	/5/		: 60
6 " "			30		/5/	5	/5/	5	/5/	5		: 60
10 " "				30	/5/	/5/	5	/5/	5	5		: 60
SV " "											60	: 60
	30	30	30	30	20	20	20	20	20	20	60	300

/ /Denotes three-way rotation

Type of offspring		Number of matings	
Straightline	1	30	
	4	30	
	6	30	
	10	30	120
Two-way rotation	1 × 4	10	
	1 × 6	10	
	1 × 10	10	
	4 × 6	10	
	4 × 10	10	
	6 × 10	10	60
Three-way rotation	1 × 4 × 6	15	
	1 × 4 × 10	15	
	1 × 6 × 10	15	
	4 × 6 × 10	15	60
Synthetic variety	(From foundation females consisting of two-line crosses of lines 1, 4, 6, and 10)	60	60
			300

The breeding plan for 1966 will conform to the scheme presented, with the following exceptions:

1. Only one sire from each line will be used
2. Crossline females will be fewer in number than shown in the preceding table
3. The synthetic variety will be omitted due to an insufficient number of females

The breeding plan for 1967 and 1968 will conform to the tabulated scheme with the following exceptions:

1. Only one sire will be used in the synthetic variety
2. Crossline females for use throughout the mating scheme (including the establishment of the synthetic variety) will be fewer in number than indicated in the preceding table.

Breeding females:

Foundation crossline females will be allotted to the two-way and three-way rotational crosses and the synthetic variety at random within age group and type-of-breeding subclass each year as long as they remain in the herd. Female offspring will be returned to their respective breeding groups. Each sound heifer will be placed in its appropriate breeding herd until the desired numbers are reached. After the desired numbers are attained, 15 percent of the heifers will be culled on the basis of physical soundness and adjusted twelve- or eighteen-month weight each year depending upon whether they will be bred at one or two years of age. Culling levels will be held as uniform as possible for all breeding groups. Cows will be culled on age (10 years), fertility (all open females three years of age or over if possible and up to a maximum of twenty-five percent of the open two-year-olds), and most probable producing ability.

Sires:

Eash straightline bull will produce offspring in the straightline, two-way rotational, and three-way rotational breeding groups. These bulls will be produced within their respective lines.

The first bull used for the synthetic variety (1967 breeding season) will be a two-line cross produced in phase 1. For the 1968 breeding season, the bulls selected for the synthetic variety will come from the three-way rotational crosses. When the synthetic variety reaches two-sire size (1969 breeding season and thereafter) sires will be selected from the three-way rotational crosses and from the synthetic variety itself. In the early or formative years, one sire will come from the three-way crosses and one from within the synthetic variety to adequately sample the germ plasm going into the other three breeding methods and holding inbreeding down.

All bulls used in phase 3 will be selected on physical soundness and adjusted final weight at the end of a 196-day feedlot test. The entire bull battery will be replaced each year.

Offspring:

Heifers will be carried through the first winter after weaning on pasture with hay and grain as necessary to maintain an average daily gain of about 0.75 of a pound per day to March 30 if they are to be bred at one year of age. A somewhat lower plane of nutrition will be provided if first breeding is delayed until they reach two years of age. Those selected as replacements, according to the procedure previously described, will be bred

to calve first at two years of age unless present studies indicate that calving at three years of age is desirable.

Bull progeny will be left intact and group fed on performance test for 196 days after weaning. The best bulls not selected for replacements or back-up bulls will be sold for breeding. The remainder will be slaughtered. Data to be obtained on the slaughter bulls will include: slaughter weight and grade, hot carcass weight, carcass grade (quality), rib-eye area, fat thickness at the 12th rib, estimates of pelvic, kidney, and heart fat. Cutability estimates will be derived from the data collected.

Duration:

It is anticipated that phase 3 will continue for 10 years with probable revision and extension about 1976.

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It was pointed out that Line 9, which was included in phases 1 and 2, was being dropped from phase 3. All possible crosses could not be made with available numbers if this line were included in phase 3. Also, this line showed the poorest performance in straightline and crossline offspring and has shown heart defects which may have a genetic basis.

Dr. Nelms raised the question of using bulls two years to obtain repeat mating information for a control. Dr. Pahnish pointed out that using bulls only one year would turn generations faster and make use of a wider sample of bulls and that repeat matings from another project might serve as an environmental control.

Dr. Stonaker stated that someone should be comparing straightbred and linecross bulls.

Dr. Warwick raised the question of culling on age as much as possible rather than on producing ability to turn generations as fast as possible.

Dr. Bogart moved approval of the project as written. Dr. Bailey seconded. Motion carried.

Montana

Dr. Blackwell stated that the Montana station contemplates revising their project during the year. He explained that the Havre project would probably be continued as is for a time but that the Bozeman project needs some revision. There is an opportunity of cooperating with the Montana State Prison, which has a herd of about 1000 Hereford cows. This project may deal with reproduction and fertility and artificial insemination would probably be used.

Professor Flower is interested in working on mating systems with laboratory species.

A study on the genetics of milk proteins has been initiated in cooperation with the U. S. Range Livestock Experiment Station.

The K 40 counter has been moved outside the state, but another may be built.

DISCUSSION OF FIRST OF PROPOSED REGIONAL BULLETINS

1. Proposed title and outline:

J. S. Brinks

Last year the committee on regional bulletins suggested a series of four bulletins dealing with studies on inbred lines of beef cattle. These were 1) The Effects of Inbreeding, 2) Response to Selection, 3) Hybrid Vigor from Linecrossing and Topcrossing, and 4) The Importance of Genetic-Environmental Interactions. Today we plan to discuss and outline in some detail the first of these dealing with the effects of inbreeding.

The proposed title and main categories in the outline were presented as follows:

Title: Studies with Inbred Lines of Beef Cattle

I. Effects of Inbreeding

Outline: Introduction
- Review of Literature
- Materials and Methods
- Results and Discussion
  - Effect of inbreeding of sire, dam, and mating on fertility
  - Effect of inbreeding of calf and dam on calf survival
  - Effect of inbreeding of calf and dam on weights, scores, and feed efficiency
    - Effect on means
    - Effect on variation
  - Interaction of levels of environment with levels of inbreeding
- Summary
- Literature Cited

The committee discussed the idea of a series with a short subtitle and most were favorable to this method.

The title was discussed in detail and an alternative of "Inbred Lines of Beef Cattle in the Western Region" was suggested. No definite decision was reached.

2. Procedures for assembling review material:

C. B. Roubicek

A list of references dealing with the effects of inbreeding in beef and dairy cattle was passed out. Dr. Roubicek made two recommendations: 1) That the literature review be concerned only with cattle (dairy and beef), and that it not cover sheep, swine, or laboratory animals, and 2) that a person or persons be assigned to review the literature with the suggestion that all participate in making sure that this individual or committee has all known references.

It was pointed out that most of the work with inbreeding in beef cattle was in the Western region and that several theses would have to be reviewed.

Dr. Roubicek agreed to take the responsibility of assembling the review material if the rest would send him the needed material.

3. Procedures for assembling Materials and Methods section:

Ralph Bogart

Dr. Bogart stated that it would be necessary for the committeeman from each state to provide information on his material. He suggested that one person or a small group should develop a form for obtaining this information and putting it together in a uniform fashion. He thought much of the information on numbers of animals, methods of management, years, breeding plans, selection methods, etc., could be put into tabular form.

It was pointed out that a questionnaire could be developed to be sent to the various stations to obtain the needed information.

Dr. Rollins moved that the coordinator be designated the main editor of the bulletin and that he appoint two other members, and that this committee write the first draft and submit it to the committee as a whole.

Dr. Bogart seconded the motion. Motion carried.

The committee is to develop a questionnaire to obtain information for the Materials and Methods section.

4. Possible procedures and statistical models for studying:

a. Effect of inbreeding of sire, dam, and mating on fertility

R. E. Christian and B. W. Knapp

Dr. Christian stated that he did not think we had studied fertility in the inbred lines because we lack methods of studying fertility adequately. He visualized fertility as being a quantitative trait that can be measured only in a qualitative way, which may be subject to large errors.

It was pointed out that for purposes of the bulletin, a useful measure is the presence or absence of a calf, and percent calf crop.

The possibility of grouping the data by discrete classes of inbreeding was discussed.

Mr. Knapp discussed possible statistical models that could be used in the analysis. One model for a least-squares analysis was:

$$Y = \mu + \text{year-station} + \text{lines/year-station} + F_s + F_s^2 + F_d + F_d^2 + F_m + F_m^2 + \text{error}$$

where F_s, F_d, and F_m refer to the inbreeding value of the sire, dam, and mating, respectively.

b. Effect of inbreeding of calf and dam on calf survival

G. E. Nelms and H. H. Stonaker

Dr. Nelms stated that statistical models for this section should be nearly the same as the last except that sex of calf should be added.

Dr. Stonaker pointed out that age of dam should be included, also. The importance of assigning a number to calves dead at birth for aiding in identification and analyses was pointed out.

The methods of analyses by least-squares and Chi square were discussed and compared. Most committeemen tended to favor the simplest model that would describe the data adequately.

Several felt that a final decision on the type of statistical model should wait until the means, distribution of data, etc., are studied.

c. Effect of inbreeding of calf and dam on weights, gains, scores, and feed efficiency

J. A. Bennett and E. H. Cobb

Dr. Bennett stated that much of the previous discussion also pertained to this section. He suggested that separate analyses be run for each sex (males versus females). Inbreeding probably should not be treated as continuous, and it is probably confounded with age of dam, time, and selection pressure.

He stated that he preferred to study preweaning daily gain rather than adjusted weaning weight. Separate adjustment factors may be needed for each station.

Measures of feed efficiency were discussed and it was pointed out that size or weight of the animal should be taken into account. Bailey mentioned that in their data the 70-day mid-weight was .98 or .99 correlated with the average of the initial and final weights. The need to relate efficiency to body composition in the future was pointed out. A term other than "feed efficiency" would be preferable for use in the bulletin.

The possibility of reviewing and studying efficiency at a future W-1 meeting was discussed with the idea of inviting nutritionists and body composition specialists to participate.

d. Interactions of levels of environment with levels of inbreeding

C. M. Bailey and R. L. Blackwell

Dr. Bailey stated that in order to study the interactions between levels of environment and levels of inbreeding we must understand the nature of the data. Some possible levels of environment that he mentioned were location, years (high and low performance), and age of dam. He also suggested analyzing the data separately by sex classes.

Dr. Blackwell wondered how unique the inbreeding values were and whether the same inbreeding coefficients may represent different levels of homozygosity at the different stations. It was pointed out that present day computers can handle these interactions much better than previously.

Dr. Burris asked whether the lines that were dropped due to low performance would be studied and what impact they would have on the conclusions. All data on lines that have been discarded are available.

5. Possible procedures for studying trends in variability within and between inbred lines:

W. C. Rollins and L. A. Holland

Dr. Rollins suggested that the variance within sires be studied by grouping levels of inbreeding of calf into discrete classes and compare the results with what is expected on the basis of theory. Based on observations, it appears that inbred lines are not as well buffered against environmental stress as outbred cattle.

After obtaining results on the above, decisions on how best to study the variance within and between inbred lines could be made.

6. Methods of publication:

O. F. Pahnish and H. H. Stonaker

Dr. Pahnish discussed the possibilities of a U. S. Department of Agriculture publication or a state publication. It would be a technical bulletin in either case. He stated that a state would be close at hand, more closely associated with the group, and be more flexible.

Dr. Meyer mentioned that the Western Directors have a set policy for a state to publish regional bulletins.

The Technical Committee favored a state publication and no further action was considered necessary.

7. Authorships:

W. C. Rollins

Dr. Rollins moved that each committeeman from a state contributing data be an author along with the coordinator. The order of authorships should be decided by the Technical Committee on the basis of the amount of data and work contributed by the committee members.

The motion was seconded by Dr. Bogart. Motion carried.

Preliminary summaries of regional data:

B. W. Knapp

Mr. Knapp presented slides and discussed the following data:

NUMBERS, MEANS, AND PERCENTS BY STATES

	California		Havre, Montana		Wyoming		Nevada	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Years	16	43-58	18	47-64	10	54-63	9	55-63
Sires	11		41		14		46	
Dams	143		344		106		306	
Matings	476		1185		358		1306	
Animals:								
Open	34	7.14	234	19.75	26	7.26	195	14.93
Aborted	9	1.89	0	.00	2	.56	7	.54
Dead at birth	26	5.46	17	1.43	28	7.82	30	2.30
Died birth to weaning	27	5.67	71	5.99	3	.84	36	2.76
Sold before weaning	16	3.36	0	.00	0	.00	30	2.30
Weaned	364	76.47	861	72.66	299	83.52	1008	77.18
Average inbreeding:[a]								
Sires		1.73		9.14		5.20		2.49
Dams		7.33		9.41		5.87		1.02
Matings		12.48		16.01		11.96		4.76

[a]Weighted by total number of matings

INBREEDING AVERAGES FOR UNSUCCESSFUL AND SUCCESSFUL MATINGS BY STATES

Trait	California		Havre, Montana		Wyoming		Nevada	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of sire:								
Unsuccessful[a]	34	2.65	234	9.79	26	4.72	195	3.01
Successful[b]	442	1.67	951	8.98	332	5.23	1111	2.40
Difference (U - S)		.98		.81		-.51		.61
Inbreeding of dam:								
Unsuccessful	34	9.65	234	11.35	26	6.51	195	1.25
Successful	442	7.14	951	8.93	332	5.82	1111	.98
Difference (U - S)		2.51		2.42		.69		.27
Inbreeding of mating:								
Unsuccessful	34	12.75	234	17.60	26	11.03	195	4.95
Successful	442	12.45	951	15.61	332	12.04	1111	4.72
Difference (U - S)		- .30		1.99		-1.01		.23

[a] Includes all open cows
[b] Includes all calves born and abortions

INBREEDING AVERAGES FOR SURVIVING AND NONSURVIVING CALVES BY STATES

Trait	California		Havre, Montana		Wyoming		Nevada	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of dam:								
Percent:								
Calves born	442	7.14	951	9.28	332	5.82	1111	.98
Abortion	9	11.03	0	.00	2	7.85	7	1.71
Dead at birth	26	7.78	17	12.51	28	8.47	30	2.17
Died birth to weaning	27	9.08	71	9.26	3	10.40	36	2.08
Abnormalities	12	8.94	16	7.78	0	.00	14	2.64
Weaned	364	7.03	861	8.84	299	5.51	1008	.92
Inbreeding of mating:								
Percent:								
Calves born	442	12.45	951	15.61	332	12.04	1111	4.72
Abortion	9	16.60	0	.00	2	25.50	7	4.00
Dead at birth	26	15.12	17	19.35	28	11.50	30	8.23
Died birth to weaning	27	14.30	71	18.17	3	14.90	36	8.50
Abnormalities	12	10.75	16	16.10	0	.00	14	11.00
Weaned	364	12.14	861	15.33	299	11.97	1008	4.54

NUMBERS, MEANS, AND PERCENTS BY LINES

Trait	California		Havre, Montana						Wyoming	
			Line I		Line II		Line III			
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Years	16	43-58	18	47-64	17	48-64	16	49-64	10	54-63
Sires	11		16	14	14		11		14	
Dams	143		114		133		97		106	
Matings	476		391		449		345		358	
Animals:										
Open	34	7.14	70	17.90	78	17.37	86	24.93	26	7.26
Aborted	9	1.89	0	.00	0	.00	0	.00	2	.56
Dead at birth	26	5.46	7	1.79	4	.89	6	1.74	28	7.82
Died birth to weaning	27	5.67	23	5.88	22	4.89	26	7.54	3	.84
Abnormal	12	2.52	5	1.28	4	.89	7	2.03	0	.00
Sold before weaning	16	3.36	1	.26	0	.00	1	.28	0	.00
Weaned	364	76.47	290	74.49	345	76.84	226	65.51	299	83.52
Average inbreeding:[a]										
Sires		1.73		9.02		10.12		8.02		5.20
Dams		7.33		11.08		8.83		8.26		5.87
Mating		12.48		14.99		15.26		18.12		11.96

[a]Weighted by total number of matings

NUMBERS, MEANS, AND PERCENTS BY LINES

	Nevada									
	Line 1		Line 2		Line 3		Line 4		Line 5	
Trait	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Years	9	55-63	9	55-63	9	55-63	9	55-63	9	55-63
Sires	9	9	9		9		10		9	
Dams	58		67		64		56		61	
Matings[a]	259		286		263		237		261	
Animals:										
Open	41	15.83	27	9.44	43	16.35	48	20.25	36	13.79
Aborted	1	.39	3	1.05	1	.38	2	.84	0	.00
Dead at birth	5	1.93	11	3.85	5	1.90	5	2.11	4	1.53
Died birth to weaning	10	3.86	7	2.45	2	.76	4	1.69	13	4.98
Abnormal	4	1.44	4	1.40	6	2.28	0	.00	0	.00
Sold before weaning	3	1.16	6	2.10	9	3.42	9	2.95	3	3.85
Weaned	199	76.83	232	81.12	203	77.19	169	71.31	205	78.54
Average inbreeding:[b]										
Sires		4.51		.65		4.39		1.00		1.96
Dams		1.53		.82		.89		1.23		.67
Matings		6.86		4.30		4.01		4.36		4.28

[a]Includes twins

[b]Weighted by total number of matings

INBREEDING AVERAGES FOR UNSUCCESSFUL AND SUCCESSFUL MATINGS BY LINES

	California		Havre, Montana						Wyoming	
			Line 1		Line II		Line III			
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of sire:										
Unsuccessful[a]	34	2.65	70	8.68	78	11.18	86	9.43	26	4.72
Successful[b]	442	1.67	321	9.07	371	9.89	259	7.55	332	5.23
Difference[c]		.98		-.39		1.29		1.88		-.51
Inbreeding of of dam:										
Unsuccessful	34	9.65	70	11.61	78	11.33	86	11.15	26	6.51
Successful	442	7.14	321	10.93	371	8.31	259	7.30	332	5.82
Difference		2.51		.68		3.02		3.85		.69
Inbreeding of mating:										
Unsuccessful	34	12.75	70	15.50	78	16.66	86	20.24	26	11.03
Successful	442	12.45	321	14.85	371	14.98	259	17.41	332	12.04
Difference		.30		.65		1.66		2.83		-1.01

[a]Includes all open cows
[b]Includes all calves born and abortions
[c](U - S)

INBREEDING AVERAGES FOR UNSUCCESSFUL AND SUCCESSFUL MATINGS BY LINE

	Nevada									
	Line 1		Line 2		Line 3		Line 4		Line 5	
Trait	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of sire:										
Unsuccessful[a]	41	3.19	27	.69	43	5.62	48	1.29	36	3.75
Successful[b]	218	4.76	259	.65	220	4.15	189	.92	225	1.67
Difference[c]		-1.57		.04		1.47		.37		1.08
Inbreeding of dam:										
Unsuccessful	41	2.32	27	1.33	43	1.07	48	1.04	36	.47
Successful	218	1.39	259	.77	220	.85	189	1.28	225	.70
Difference		.93		.56		.22		-.24		-.23
Inbreeding of mating:										
Unsuccessful	41	5.78	27	5.00	43	3.81	48	4.77	36	5.56
Successful	218	7.06	259	4.23	220	4.05	189	4.26	225	4.07
Difference		-1.28		.77		-.24		.51		1.49

[a]Includes all open cows
[b]Includes all calves born and abortions
[c](U - S)

INBREEDING AVERAGES FOR SURVIVING AND NONSURVIVING CALVES BY LINES

	California		Havre, Montana						Wyoming	
			Line I		Line II		Line III			
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of dam:										
Percent:										
Calves born	442	7.14	321	10.93	371	8.31	259	7.30	332	5.82
Abortion	9	11.03	0	.00	0	0.00	0	0.00	2	7.85
Dead at birth	26	7.78	7	14.53	4	14.55	6	8.85	28	8.48
Died birth to weaning	27	9.08	23	10.29	22	8.72	26	8.80	3	10.40
Abnormalities	12	8.94	5	8.24	4	12.05	7	5.02	0	.00
Weaned	364	7.03	291	10.91	345	8.21	226	7.12	299	5.51
Inbreeding of mating:										
Percent:										
Calves born	442	12.45	321	14.85	371	14.98	259	17.41	332	12.04
Abortion	9	16.60	0	0.00	0	.00	0	.00	2	25.50
Dead at birth	26	15.12	7	20.01	4	21.50	6	17.13	28	11.50
Died birth to weaning	27	14.39	23	14.92	22	17.10	26	21.96	3	14.90
Abnormalities	12	10.75	5	13.72	4	16.03	7	17.84	0	.00
Weaned	364	12.14	291	14.69	345	14.77	226	16.92	299	11.97

INBREEDING AVERAGES FOR SURVIVING AND NONSURVIVING CALVES BY LINES

	Nevada									
	Line 1		Line 2		Line 3		Line 4		Line 5	
Trait	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Inbreeding of dam:										
Percent:										
Calves born	218	1.39	259	0.77	220	0.86	189	1.28	225	0.70
Abortion	1	.00	3	.00	1	.00	2	6.00	0	.00
Dead at birth	5	5.00	11	3.28	5	.00	5	.40	4	.50
Died birth to weaning	10	3.10	7	.00	2	6.00	4	6.50	13	.46
Abnormalities	4	6.25	4	3.00	6	.00	0	.00	0	.00
Weaned	199	1.24	232	.70	203	.87	169	1.12	205	.72
Inbreeding of mating:										
Percent:										
Calves born	218	7.06	259	4.23	220	4.05	189	4.26	225	4.07
Abortion	1	28.00	3	.00	1	.00	2	.00	0	.00
Dead at birth	5	10.60	11	8.55	5	8.00	5	6.00	4	7.50
Died birth to weaning	10	13.30	7	7.00	2	11.00	4	8.00	13	5.38
Abnormalities	4	12.50	4	10.50	6	10.33	0	.00	0	.00
Weaned	199	6.55	232	4.09	203	3.95	169	4.15	205	4.00

Similar summaries from the remaining stations will be distributed to the W-1 Technical Committee when completed.

Dr. Rollins moved that the Committee express appreciation to Mr. Knapp and Dr. Brinks for their diligence in preparing the tabulations.

Dr. Nelms seconded. Motion carried.

COMMENTS OF REGIONAL ADMINISTRATIVE ADVISER

Dr. Stonaker:

We have had but three Administrative Advisers of W-1. Dr. Meyer of California is the latest one. We are pleased that he would accept this responsibility. We will be happy to have anything you wish to say presented at this time, Dr. Meyer.

Dr. Meyer:

I was very much interested in Stony's comments on the history of W-1. My opinion of this group has come up after becoming acquainted and sitting in on your work.

Cattle breeding is sometimes frowned on and you of all people are in more trouble than anyone else in the College of Agriculture because you have to produce something useful 20 years from now. Judging the future is a real problem. Stony mentioned the project is 20 years old and it might go on for another 100 years. We should explore what is going to be needed in another 100 years. In the next 100 years will there be any beef cattle?

When you look at the expected increase in the human population and you see that 3 billion of that 3.4 billion expected increase is going to be in the underprivileged countries, it gives you something to consider so far as the beef industry is concerned. How are we going to feed a cattle population? Already there is talk of our being short of food for human consumption. We are shipping wheat. It is going to have an influence on the beef industry.

Since beef cattle breeding is so slow we must be aware and look ahead. Animal husbandry may be the most wonderful field in the world, but I was interested, also, in the research that produced the mechanical harvester for tomatoes. Then the tomato was developed that could be harvested mechanically. A machine was produced, then a tomato was bred that had a hard skin, could be bounced, would hold up under mechanical harvesting.

Another crop that has attracted my interest has been strawberries. A Shasta strawberry is enormous but doesn't taste very good. Some varieties had good flavor but low yields. Varieties were introduced that increased yields 30 percent and retained good flavor. And it didn't take very long.

At the same time, a group started working on methods of storing or decreasing postharvest rot in strawberries. Some scientists worked on what irradiation did to the metabolism of fruits. They reduced loss from 30 percent to 5 percent. This work is keeping California in the strawberry business.

The question is, are we going to stay in the beef business? You could conceivably eat strawberries. You might not enjoy them as well as beef, but they are getting cheap. And those scientists did not have the emotional attraction to the Shasta strawberry that we have to the various breeds of cattle.

Dr. Koger mentioned forming new breeds. We may not want a new one. We are going to have to go out and get genes from dairy cattle, yaks, or whatever.

Research being done on genetic-environmental interactions is very important and you may have to fit some classes of animals to specific environments. That may be a major contribution you can make.

I was talking with Everett Warwick about body composition and about the Wyoming project. The cost of storing semen versus feeding the bulls, etc. This sort of thing could work well.

That is all I wanted to say. I am glad I am going to be with this committee. I do think it has much to offer and it is going to have to be the most imaginative for it is the most influential committee we have.

Dr. Stonaker:

We are all pleased to have your vigor and imagination involved with this project. There is nothing that does not cost money, and you need these very striking examples to impress the people who have the money. I think we can furnish such examples.

COMMENTS OF COOPERATIVE STATE RESEARCH SERVICE REPRESENTATIVE

Dr. Burris:

This area of animal breeding has made what constitutes a landmark with its 20th Anniversary. We need these landmarks as they occur from year to year or time to time when something of considerable significance happens. Frequently you may have results of genetic studies that you feel are significant occurrences such as when a notice came across my desk that there would be a bull sale at Fort Lewis and bulls would be guaranteed to produce superior progeny. I felt this was quite a landmark--the fact that we are willing to stand by what our genetic information proves to us.

A couple of other ideas that I think I will mention, we talked a great deal here about analysis of joint or pooled data, in which we would come up with kind of a general or group answer. I think we need to look quite a little more at the joint planning. You get concerned when you look back at things and try to see how you are going to interpret the data.

Is there a real need for more joint planning in the W-1 project? I would say there is. You might say it is difficult to get the job done that way, but it has interlocking responsibilities, one to the other, to the industry, and to your state, but we have as great a responsibility to the beef cattle industry as a whole. I think we should look at these as not answering the question for local needs only but for the beef cattle industry in general.

Nolan Farris, head of our group and responsible for over-all research work, will retire the end of August.

Dr. Burris distributed and discussed the following "Items of Interest to the Technical Committee":

1. The following statement appeared on a recent report of research from a regional project. Will this committee be able to make such a statement?

   "Six participating states were able to work together on a uniform basis to obtain and present results that were truly regional in perspective. Without this cooperation and the use of uniform methods and procedures, many of the pertinent findings would have been masked by individual state interpretations. In turn, this would have greatly reduced the usefulness of the findings and their application to the solution of current problems and future investigations."

2. Justification for new and expanded programs requires evidence of research accomplishments. A recent such accomplishment in livestock is the development of poloxaline for bloat prevention by several state experiment stations. We are constantly in need of current accomplishments in animal breeding and would appreciate any suggestions you may have.

3. A joint state (SAES) and USDA group have been working for several months on the Long Range Study of Agricultural Research Programs and Needs. Inventories of scientific man years and expenditures were recently summarized. Of the 10,905 man years in the SAES and USDA, 2,105 are in livestock and poultry, with 514 in beef cattle. Beef cattle production has 258 man years, of which 229 are at the SAES.

4. A meeting authorized by the Committee of Nine was held in Chicago, Illinois on May 27, 1966, to discuss acute problems of the swine industry and action programs necessary to correct these difficulties. Subsequent meetings are planned with possibility of developing a package program for swine research needs.

5. The Committee of Nine (directors) have recently suggested changes in regional procedures which are of concern to this committee. These changes include limitation to a three-page annual report, publications, emphasis on accomplishments, and preparation of meeting minutes. Copies of the Committee of Nine suggestions have been supplied to your committee chairman and investigations leader.

6. Several bills have been introduced in Congress on control of purchasing and handling of experimental animals by dealers. Originally aimed at conditions existing in the theft of pets and their subsequent use in research, certain bills apply only to dogs and cats, while others apply to all species and may include, also, regulation of activities in the research laboratory. Hearings were held in the fall of 1965 and spring of 1966 for several bills. HR 13881 amended was passed by the House of Representatives. A much more restrictive version of HR 13881 was reported by the Commerce Committee of the Senate.

7. Numerous bills have been introduced in Congress dealing with regulation of research use of animals. HR 5191 is considered to be a constructive bill by certain research animal organizations while S 1087, S 1071, HR 5647, HR 3036, HR 7312, HR 10049, HR 10050, HR 10620, HR 10589, HR 10213, and HR 10355 and similar bills are considered restrictive of research. Copies of these bills are available from the Senate and House Document Rooms, respectively.

8. Bills introduced in Congress to consolidate current laws and regulations administered by the Food and Drug Administration on the use of drugs in animals include HR 7655, 7797, 7815, 8377, and 9542. Hearings were held on June 13, 1966, before the House Committee on Interstate and Foreign Commerce.

9. The USDA amended its Meat Inspection Regulations in January 1965 to set forth procedures for acceptance or rejection for food of animals used in experimental research that are to be slaughtered at federally inspected plants. Recently the Food and Drug Administration, HEW, has also established procedures for authorizing marketing of edible products of experimental animals and for use of new drugs in investigational use.

10. On June 1, 1965, HR 8665, a bill to require Federal inspection of

slaughter for human food purposes of animals used in research was introduced in Congress. The bill covers cattle, sheep, swine, goats, reindeer, horses, and poultry in which animals were subjected to the causative agent of any disease or any chemical, radiation, or other force capable of affecting the animal or any of of its biological processes in any way.

11. On August 4, 1965, Public Law 89-106 was enacted, in part, providing the Secretary of Agriculture with the authority to make research grants to a wide range of recipients. This will also extend existing authority (under Public Law 85-394) to include applied research.

12. Current funds available through CSRS for research include Hatch Act, $48,113,000; McIntire-Stennis (Forestry), $2,500,000; Basic Research $2,000,000 and Facilities $2,000,000 with a total of $54,795,000. The President's budget for the forthcoming year currently bears a marked reduction of Hatch funds. The House of Representatives, however, voted to restore the CSRS budget to the above values. (Current year ending June 30, 1966, and forthcoming year beginning July 1, 1966.)

COMMENTS OF CHIEF, BEEF CATTLE BREEDING RESEARCH

Dr. Warwick:

Some of the things Dr. Meyer talked about made me think of a book published in about 1951 or 1952 by an engineer named Charles Darwin--a grandson of the Charles Darwin of biological fame. The book is entitled "The Next Million Years," and is on the population and food production question. You might be interested in reading it. The author stated that one way to write this kind of book is to spend a lifetime of research first, the other is just to write the book. Since he started serious study of the problem late in life, he had of necessity "just written the book", but felt the conclusions wouldn't have changed with a lifetime of research.

He started from the premise that man is a wild animal, and defined a wild animal as one which reproduces up to the limit of its food supply. On the basis of these two ideas, he predicted that intermittent wars and famines were inevitable over the next million years.

I like to take an optimistic view and hope that we as scientists will have something to do with upsetting these dire predictions.

We are living in an era of change, and the changes include patterns of agricultural research. Two stories will perhaps serve to drive home the inevitability of change. About 20 years ago I heard a man recount the experience of attending the 100th birthday party of a man in Idaho--a man who had been born in a log cabin in Iowa but had migrated to Idaho as a young man. The old man recalled the Civil War, the depressions of the 1870's and 1890's, drought, his first telephone conversation, his first automobile ride, his first sight of an airplane, World War I, the depression of the 1930's, World War II, etc. He had lived 100 years, but he had not lived through a single year of normal times! Change is ever with us.

A friend recently reported attending a man's 95th birthday party. Someone said to the 95-year-old that he must have seen many changes in his long life. He replied, "Yes, and I've been against them all." This is a most unfortunate attitude. All of us sometimes find ourselves opposing change, but we must adapt ourselves to it.

Agricultural budgets of the past few years have been one of the most difficult things some of us have encountered. I am confident, however, that if we adapt our programs to needs of the times we can be even more productive in the future than in the past.

Organizationally, beef cattle breeding research has followed essentially the same pattern for about 20 years. Regional projects involving cooperation between the U. S. Department of Agriculture and State Agricultural Experiment Stations have been active in three regions. The Department has employed a Coordinator--more recently called an Investigations Leader--in each region. These men have worked with both State and Federal personnel. This spring two of these positions became vacant. Questions had been raised as to the necessity of these positions now. Had times

changed so that such positions were no longer necessary, and if so should we consider a change in the positions, a change in the functions of the men in the positions, or the abolishment of the positions? Since the time seemed opportune to examine these questions, representatives of the three regions were brought together to discuss possibilities at a meeting in mid-April in Beltsville. Those present included Administrative Advisers from two regions, the Chairmen of the three Technical Committees, the three Investigations Leaders, and administrative personnel of the Cooperative State Research Service and the Agricultural Research Service. The meeting was for discussion only. But those present seemed to be unanimous in expressing the idea that these positions were highly useful and might be even more useful in the future if we move further into studies combining data from many locations. This is the type of thing we have been talking about the past two days. On the basis of the expressed opinion, we are taking steps to find replacements and fill the two vacant positions and intend to keep Dr. Brinks in the position in the Western Region.

I would like to comment on the fear of some people, especially in the Western Region, that the development of the U. S. Meat Animal Research Center at Clay Center may have a deleterious effect on beef cattle breeding research both in the Western Region and at other locations over the country. There is no thought on the part of the Beef Cattle Research Branch or anyone in the Agricultural Research Service that this will happen. Rather, we look on the development of the Clay Center facility and its operations as an opportunity to assist and cooperate on a scale that has not heretofore been possible. I hope the facility will always be integrated with other segments of the research program--both Federal and State. There is every reason to believe that the facility will develop in that fashion rather than as a place that will compete for dollars which might go for something else.

Congress last year appropriated money for planning physical facilities for Clay Center and also money to initiate the development of a research program. So far this has of necessity been used for the development of pastures, fences, and that type of thing. The current budget calls for an increase in operating budget and an appropriation of about half the money which eventually will be needed for physical facilities. About 35,000 acres of land has been transferred to the Department of Agriculture.

Dr. Stonaker said something yesterday about the slowness of adoption of results from a program of beef cattle breeding research and Dr. Meyer suggested we would have to expect it would be 20 years before the results were actually adopted and put into use. We have all been concerned about the slowness of the adoption of results. However, there is an optimistic side. Last year in the United States something over half a million cattle in breeding herds were under performance testing programs. Certainly, we should be giving more attention to stimulating the adoption of the things we learn. Probably of necessity, pressures for adoption of many changes will start at the top of the heap with the consumer and be transmitted back through the chain of retailer, packer, feeder, and commercial herds to the seedstock herds which ultimately control the genetic composition of the nation's beef herds. With this chain to be considered, Dr. Meyer's 20-year figure may not be too far off.

To date we have been working pretty much with commercial herds and with multiplier segments of the seedstock group but have not touched the elite group of seedstock breeders to any great degree. Perhaps reaching them will be possible only through more attention to the entire chain--starting with the consumer.

A few weeks ago I had a letter from a purebred beef cattle breeder who has given a lot of thought to the general probelm of getting breeders to make use of the tools of science in approaching their task. He suggested that the U. S. Department of Agriculture should develop rules for livestock shows which would emphasize performance and, if necessary, establish new shows for this purpose. I am afraid this isn't a feasible proposal, but all of us are in positions where we can bring some influence to bear on procedures used in shows. Perhaps we should be making greater use of the opportunities this gives us.

As Dr. Meyer mentioned, we must be making a continual evaluation of where the money available for research can be spent to best advantage, i. e., to yield greatest returns. A budgeting system designed to accomplish this has been introduced in the Federal Government and is called Programmed Planning Budget System--PPB for short. We must justify every request for funds. We must show the benefits which can be expected from each dollar spent in any type of research. One difficulty of the system comes in justifying basic research. However, the problem must be faced. I expect most states are likely to be operating under this or a related budget system if not already doing so.

The question of inbred lines is pertinent in relation to budgets. The Western Region has traditionally had more inbred lines than any other region, and I sense a feeling that this general approach should be further expanded in beef cattle breeding. A year ago last spring we had a meeting in Beltsville on the subject of inbreeding and line crossing as techniques or tools for livestock improvement. Persons in attendance included geneticists in our Division working with all classes of livestock plus a few state people with special interests in the subject. In general, the beef cattle people were the only ones who seemed to have much faith or interest in these techniques. A good many of the others felt they had tried them and that they had failed. It was freely suggested that we should get rid of our inbred lines and get into more productive lines of research. I gathered the same thoughts from Alan Robertson when he spoke before this Committee a year ago. I do not believe others should dictate our research plans, but I do think it indicates that we need to take a critical look at the inbred line approach. This is what you should do in the proposed summary which has been discussed at this meeting. If it does not have real promise, we should go to some other technique. We must admit the use of inbred lines has had quite a fair trial with swine and has been largely abandoned. Poultry breeders tried the inbred line approach but I understand have generally turned to other techniques. A number of sheep lines are being used in research but it is by no means certain that they and their crosses have brought about a lot of improvement. Thus, I feel we should have a questioning attitude on this type of research, especially the beginning of new lines. I have defended the continuation of existing inbred lines at Federally-owned stations on the basis that much time and

money has been spent developing them and they should not be discarded without a thorough evaluation of all the evidence on their potential usefulness.

Have those of you thinking of starting new inbred lines critically examined the question of whether this is the best use of your facilities for the next 15 to 20 years, which I presume will bring some of you to retirement age? That may be an unfair question, but we do need to look at these things critically.

In view of what has been said about population changes in the future, it seems almost inevitable that in the next 20 years we are almost sure to reach a stage in which we will have to rely more on forage and less on grain for beef cattle production. The industry of the future may be essentially a user of grass that otherwise could not contribute to human food supplies. Could some of our small herds be set up to determine what possibilities selection has for improving efficiency of forage use?

COMMENTS OF COORDINATOR

Dr. Brinks:

I am happy to report that all of you have your reports in. They are in good shape and we will get them into bound form as soon as possible. Also, Mrs. Neely has just about completed an updated list of W-1 publications which will be mimeographed and sent to you.

I think Dr. Bogart mentioned last year we were not getting enough of the W-1 publications circulated to the committeemen in our own and the other regions. We should have 60 copies of all W-1 publications sent to our office so we may send them to our own committeemen and the other two regional committees. We plan to remind you a little more often so you will send us your copies and we can distribute them as we have in the past.

Project revisions that will be due next year are Utah and Montana.

If we can help in assembling material for your field days or talks, or aid in furnishing computer programs, please let us know. Brad has the Montana inbreeding program working on the CDC 3600. Also, he is adapting the least-squares program to this machine. If you need help in programming your own computers, possibly Brad could help in that situation.

I attended the S-10 meeting a week ago and there was some discussion of a joint interregional meeting again some time. No specific program or specific place was mentioned. If you have any ideas for an interregional program, possibly we can discuss it during the business meeting.

Dr. Warwick covered the meeting at Beltsville to review the investigations leader positions. I think we are in a little stronger position now and the regional beef cattle breeding programs are on a very sound ground.

Dr. Burris spoke of landmarks. I think it is a little difficult to identify these in cattle breeding. We have accumulated a lot of general knowledge on genetic parameters, techniques of performance and progeny testing, etc. They are landmarks of a type, not specific instances, but general landmarks.

We have a lot of work ahead. Dr. Meyer mentioned that we need new ideas in developing new projects.

We have a lot of work ahead on the regional bulletin, and all of us will have to work on this. We will get the committee appointed and also keep you informed on how we are progressing from time to time.

TIME AND PLACE OF NEXT MEETING

Chairman Stonaker entertained discussion on the election of a new chairman, and time and place of the next meeting.

Dr. Bogart moved that the committee continue to elect the chairman alphabetically and that Dr. Cobb be elected chairman of the W-1 Technical Committee for the next year.

Dr. Nelms seconded. Motion carried.

Dr. Bogart moved that the next W-1 Technical Committe meeting be held just prior to the American Society of Animal Science meetings in Reno, Nevada.

Dr. Cobb seconded.

Dr. Stonaker mentioned that California had issued an invitation and that another possibility was to meet in conjunction with the Body Composition Conference in Missouri next March.

Dr. Roubicek stated that a good time to view the Arizona project would be in February or March since the cattle would be on test at that time.

Dr. Warwick suggested that the committee think of a joint meeting with the other two regions in the future and that Dr. Hobbs asked him to extend an invitation to W-1 to meet in Tennessee with the S-10 group in 1967. The committee felt that a joint meeting in 1968 would allow more time for planning. The International meetings to be held in Beltsville in 1968 was mentioned as a possible time for a joint meeting.

Dr. Christian called for the question.

Motion carried to meet in Reno just prior to the American Society of Animal Science meetings.

Dr. Stonaker called for the report from the Resolutions Committee.

RESOLUTIONS

Members of the Animal Science Department of the New Mexico Agricultural Experiment Station, and particularly Dr. Holland, have done an excellent job of providing the members of the W-1 Technical Committee with facilities and services which have made our meeting effective, successful, and pleasant. Therefore,

BE IT RESOLVED that the W-1 Technical Committee extend its thanks to the members of the Department through a letter to the Department and a copy to the Dean of Agriculture.

Dr. Bogart moved that the resolution be adopted. Dr. Nelms seconded. Motion carried.

BE IT RESOLVED that the W-1 Technical Committee express appreciation by letter to Dr. P. W. Gregory for his efforts in preparing a summary of his current bovine achondroplasia research and for distributing summaries to the W-1 Committee at Dr. Brinks' suggestion. This work is of value to the cattle industry and the W-1 committee appreciates his efforts in this area.

Dr. Bogart moved that the resolution be adopted. Dr. Bennett seconded. Motion carried.

Dr. H. H. Stonaker has contributed greatly in many ways to the effectiveness of the W-1 research and it is with regret that we must see him concentrate his efforts in other areas. It is because of our high esteem for Dr. Stonaker that the W-1 Technical Committee expresses its thanks for his past services to the Committee and its sincere wishes of success to Dr. Stonaker in his new assignment.

Dr. Bogart moved acceptance. Dr. Nelms seconded. Motion carried.

Resolutions Committee
Dr. J. A. Bennett
Dr. R. E. Christian
Dr. G. E. Nelms
Dr. Ralph Bogart, Chairman

ADJOURNED